Prime Item Development Specification: Combustion Integrated Rack

Fluids and Combustion Facility Combustion Integrated Rack

Final
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AUTHORIZED by CM when under FORMAL Configuration Control	
Date	**Signature**
10/28/00	*/s/ Robert H. Van Niel*

Prepared For:
National Aeronautics and Space Administration
John H. Glenn Research Center
Microgravity Science Division
Cleveland, Ohio 44135

Prepared By:
Federal Data Corporation
Under Contract NAS3-99155
2001 Aerospace Parkway
Brook Park, Ohio 44142

**Prime Item Development Specification
for the
Fluids and Combustion Facility
Combustion Integrated Rack**

**Configuration Item No.: 67212MFAH10000
Contract No.: NAS3-99155
CDRL Sequence No.: Not Applicable**

**Prepared For:
National Aeronautics and Space Administration
John H. Glenn Research Center**

**Prepared By:
Federal Data Corporation
Cleveland, Ohio**

Authenticated By: ______________________________ Date: _________________

Approved By: __________________________________ Date: _________________

PREFACE

The National Aeronautics and Space Administration is developing a modular, multi-user experimentation facility for conducting fluid science and combustion science experiments in the microgravity environment of the International Space Station (ISS). This facility, called the Fluids and Combustion Facility (FCF), consists of three test platforms: the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Shared Accommodations Rack (SAR). This document defines the requirements for the CIR and is the source for CIR technical and verification requirements.

This specification was prepared as a Type B1 Prime Item Development Specification, Form 1b, as defined in NASA document SSP 41171. It defines the CIR development item, applicable documents, characteristics that the CIR must exhibit, design and construction requirements, computer resource requirements, logistics requirements, personnel and training requirements, and characteristics of any subordinate elements. This document also discusses quality assurance provisions, preparation for shipping, and notes.

**PRIME ITEM DEVELOPMENT SPECIFICATION:
FLUIDS AND COMBUSTION FACILITY
COMBUSTION INTEGRATED RACK (CIR)**

Prepared By: */s/ Lowell E. Wolfe* **Date:** *10/23/00*
Lowell E. Wolfe
Systems Engineer
Analex Corporation

Approved By: */s/ Tom Ziemianski* **Date:** *10/23/00*
Tom Ziemianski
Technical Operations Manager
Hernandex Engineering Incorporated

Approved By: */s/ Jon Wetherholt* **Date:** *10/23/00*
Jon Wetherholt
Systems Engineering Manager
Analex Corporation

Approved By: */s/ Martin O'Toole* **Date: :** *10/23/00*
Martin O'Toole
CIR PDT Lead
Analex Corporation

Approved By: */s/ Andrew M. Peddie* **Date: :** *10/23/00*
Andrew Peddie
FCF Deputy Director
Federal Data Corporation

Approved By: */s/ Christopher J. Pestak* **Date: :** *10/23/00*
Christopher Pestak
FCF Director
Analex Corporation

REVISION PAGE
CIR PRIME ITEM DEVELOPMENT SPECIFICATION

Revision	Date	Description of Change or ECO's Incorporated	Verification and Date
Draft	2/10/99	Initial Draft for MRDOC RFP	
Draft	07/14/00	Initial	
Final	10/16/00	Initial Release for PDR	10/23/00

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1.0 SCOPE

This specification establishes the performance, design, development, and qualification requirements for the Combustion Integrated Rack (CIR) in both its launch configuration and its on orbit configuration. The CIR is part of the United States Laboratory Module (US Lab) Fluids and Combustion Facility (FCF) of the International Space Station (ISS). This specification is prepared per the format as specified in SSP 41171. The CIR for the Ground Integration Unit, Engineering Development Unit and the Payload Training Center Unit, are covered in the Ground Segment Specification, FCF-SPEC-0005.

1.1 Identification.

This specification covers the CIR configuration item 67212MFAH10000.

1.2 Classification.

No type, grade, class, or other similar designation is applicable at this time.

1.3 International standardization agreement code.

International standardization agreement code numbers are not applicable to the configuration item defined by this specification.

1.4 Assembly overview.

The CIR is part of a modular, multi-user facility whose primary purpose is to perform sustained, systematic research in the discipline of combustion science. The CIR is the first FCF segment to be installed as a permanent facility within the US Lab.

1.5 TBD’s and Exceptions.

Approved exceptions to the requirements of this specification are provided in Appendix H. TBD’s are given in Appendix I.

2.0 APPLICABLE DOCUMENTS

This section discusses all documents, including both government and nongovernment documents, applicable to this specification.

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks.

2.1.1.1 Federal specifications.

Not applicable.

2.1.1.2 Military specifications.

MIL-C-38999	Connector, Electrical, Circular, Miniature, High Density Quick Disconnect, (Bayonet, Theaded, and Breech Coupling), Environmental Resisting, Removable Crimp and Hermitic Solder Contacts, General Specification for
MIL-C-5015	Connectors, Electrical, Circular Theaded, An Type, General Specification for
MIL-C-81569	Connectors, Electrical Rectangular, Crimp Contact, General Specification for
MIL-C-83733	Connectors, Electrical Miniature, Rectangular Type, Rack to Panel, Environmental Resisting, 200° F Total Continuous Operating Temperature, General Specification for

2.1.1.3 Federal standards.

FED-STD-595	Federal Standard Colors Used in Government Procurement

2.1.1.4 Federal information processing standards.

Not applicable.

2.1.1.5 Military standards.

MIL-STD-461	Electromagnetic Emissions and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of

	Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Document
MIL-STD-1553B	Digital Time Division Command/Response Multiplex Data Bus Handbook

2.1.1.6 Military handbooks.

MIL-HDBK-1553	Digital Time Division Command/Response Multiplex Data Bus Handbook

(Copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents order desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other government documents, drawings, and publications.

The following other government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the exact issue shown applies to this specification.

2.1.2.1 Other government documents.

FCF-PLN-0036	Material and Processes Control Plan
FCF-DOC-002 Rev. A 04/99	Science Requirements Envelope Document – Fluids and Combustion Facility
FCF-DOC-004 Rev. A 04/99	Compliance Matrix, Science Requirements Envelope Document – Fluids and Combustion Facility
FCF-SPC-0001	Systems Specification – International Space Station Fluids and Combustion Facility
JSC 27199 Rev. A 03/97	End Item Specification for the International Space Station Portable Utility Light
CIR-PLN-0056	Combustion Integrated Rack Verification Plan
JSC 27260 Rev. B 09/08/97	Decal Process Document and Catalog
JSC, MA2-95-048	NASA IVA Touch Temperature Safety interpretation letter
MSFC-STD-275	Marking of Electrical Ground Support Equipment, Front Panels, and Rack Title Plates
MSFC-SPEC-250	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for Document
MSFC-STD-531	High Voltage Design Criteria
NASA-STD-5003	Fracture Control Requirements for Payloads Using the Space shuttle

NHB 5300.4(1B)	Quality Program Provisions for Aeronautical and Space System Contractors
NHB 6000.1	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
NSTS 1700.7 ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
NSTS 13830	Implementation Procedure for NSTS Payloads System Safety Requirements
NSTS 18798	Interpretations of National Space Transportation System (NSTS) Payload Safety Requirements
SN-C-0005	NSTS Contamination Control Requirements Manual
SSP 30237	Space Station Requirements for Electromagnetic Emissions and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques
SSP 30240	Space Station Grounding Requirements
SSP 30242	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	Space Station Electrical Bonding Requirements
SSP 30257:004	Space Station Program Intravehicular Activity (IVA) Restraints and Mobile Aid Standard Interface Control Document (ICD)
SSP 30262:013	Smoke Detector Assembly Standard ICD
SSP 30312	Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan for Space Station Program
SSP 30423	Space Station Approved Electrical, Electronic, and Electromechanical Parts List
SSP 30426	External Contamination Control Requirements
SSP 30482 (V1)	Electric Power Specifications and Standards, Vol. 1: EPS Performance Specifications
SSP 30482 (V2)	Electric Power Specifications and Standards, Vol. 2: Consumer Restraints
SSP 30512	Ionizing Radiation Design Environment
SSP 30573	Space Station Program Fluid Procurement and Use Control Specification
SSP 41171	Preparation of Program-Unique Specifications – International Space Station Program
SSP 41002	International Standard Payload Rack to NASA/NASDA Modules Interface Control Document
SSP 41017	Rack to Mini Pressurized Logistics Module ICD Part 1 and Part 2
SSP 41175-02	Software ICD Part 1 Station Management and Control to ISS Book 2 General Interface Software Interfaces Requirement
SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) Document
SSP 50184	High Rate Data Link Physical Media, Physical Signaling and

	Protocol Specifications
SSP 50313	Display and Graphical Commonality Standard
SSP 52005	ISS Payload Flight Equipment and Guidelines for Safety Critical Structures
SSP 52050	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 57000	Pressurized Payloads Interface Requirements Document
SSP 57001	Pressurized Payload Hardware ICD
SSP 57002	Pressurized Payload Software ICD
SSP 57007	ISPR Structural Integrator's Handbook
SSP 57010	Pressurized Payloads Generic Payload Verification Plan
SSP 57011	Payload Verification Plan
SSP 57020	Pressurized Payload Accommodations Handbook
SSP 57217	FCFCIR Hardware ICD
SSQ 21635	Connectors and Accessories, Electrical, Rectangular, Rack and Panel
SSQ 21654	Cable, Single Fiber, Multitude, Space Quality, General Specification for Document
SSQ 21655	Cable, Electrical, MIL-STD-1553B Data Bus, Space Quality, General Specification for Document

2.1.2.2 Drawings.

Not applicable.

2.1.2.3 Publications.

Not applicable.

2.2 Nongovernment documents.

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the content of this specification, the content of this specification shall be considered a superseding requirement.

2.2.1 Specifications.

2.2.2 Standards.

ISO/IEC 8802-3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specification

2.2.3 Other publications.

220G07455	Rack Handling Adapters – Upper Structure
220G07470	Rack Handling Adapters – Lower Structure
220G07475	Rack Handling Adapters - KSC Lower Structure
220G07500	Rack Shipping Containers
CCSDS 301.1-B-2	CCSDS Time Code Format
CCSDS 701.0-B-2	Advanced Orbiting Systems, Network and Data Links: Architectural Specification, Blue Book
EIA/TIA RS-250-C	Electrical Performance for Television Relay Facility
D683-10007	Fire Detection Assembly
683-17103	Fluid System Server Interface Definition Drawing
NTC-7	Video Facility Testing Technical Performance Objectives (NTC)
D684-10056-01	International Space Station, Prime Contractor Software Standards and Procedures Specification

2.3 Order of precedence for documents.

In the event of a conflict between this document and other documents referenced herein, the requirements of this document shall apply. In the event of a conflict between this document and the contract, the contractual requirements shall take precedence over this document. All documents used, applicable or referenced, are to be the issues defined in the Configuration Management (CM) contract baseline. All document changes, issued after baseline establishment, shall be reviewed for impact on scope of work. If a change to an applicable document is determined to be effective, and contractually approved for implementation, the revision status will be updated in the CM contract baseline. The contract revision status of all applicable documents is available by accessing the CM database. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 REQUIREMENTS

The requirements that form this document are found in FCF-DOC-002 in association with FCF-DOC-004, FCF-SPC-0001, and SSP 57000 as listed in the Dynamic Object Oriented Requirements System (DOORS) program.

3.1 CIR definition.

3.1.1 CIR description.

The CIR can either be in a launch configuration or an on orbit configuration. It is packaged in a program furnished International Standard Payload Rack (ISPR). In the launch configuration, the CIR is placed in a Multi-Purpose Logistics Module (MPLM) along with associated stowage items that will make up the CIR on orbit configuration. Once the CIR is installed in the US Lab, astronauts will complete the assembly to the CIR on orbit configuration. Figure 1 and Figure 2 show the launch and on orbit CIR configurations. (Note: In the actual launch configuration, the Optics Bench will not be deployed and the rack doors will be closed.) In conjunction with Principal Investigator (PI) hardware and software, the CIR will perform sustained, systematic research in combustion science. Most of the requirements derived from FCF-DOC-002 cannot be met or verified without PI or PI-simulated hardware and/or software.

3.1.2 CIR mission.

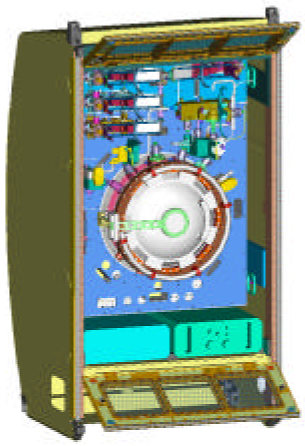
The CIR mission is to perform microgravity experiments in combustion science over the life of the FCF. The expected life of the CIR is twelve to seventeen years.

3.1.3 Threat environment.

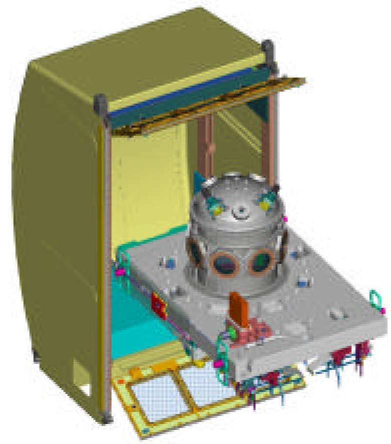
Not applicable.

3.1.4 CIR functional schematic.

The CIR is nonoperational in its launch configuration. Figure 3 shows the functions of the CIR. The CIR will be designed to allow investigation in combustion science using gaseous, liquid, and solid fuels at various pressures and oxygen concentrations to better understand the combustion processes. The microgravity environment allows for measurement and observation of combustion processes that cannot be made in sustained gravity. The modular design of the CIR assemblies allows for flexibility in configuring for specific experiments and easy maintainability of the hardware.

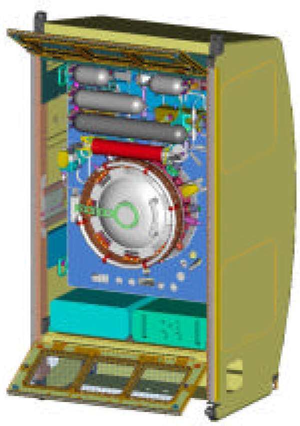


Optic bench front view

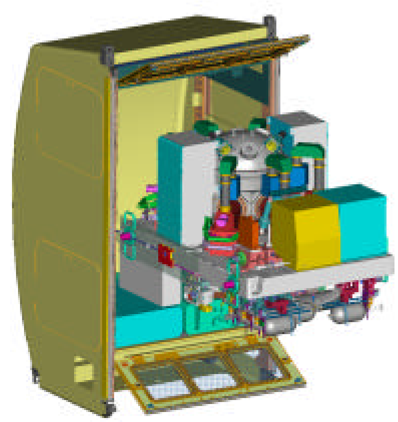


Optic bench rear view

Figure 1. CIR launch configuration



Optic bench front view



Optic bench rear view

Figure 2. CIR on orbit configuration

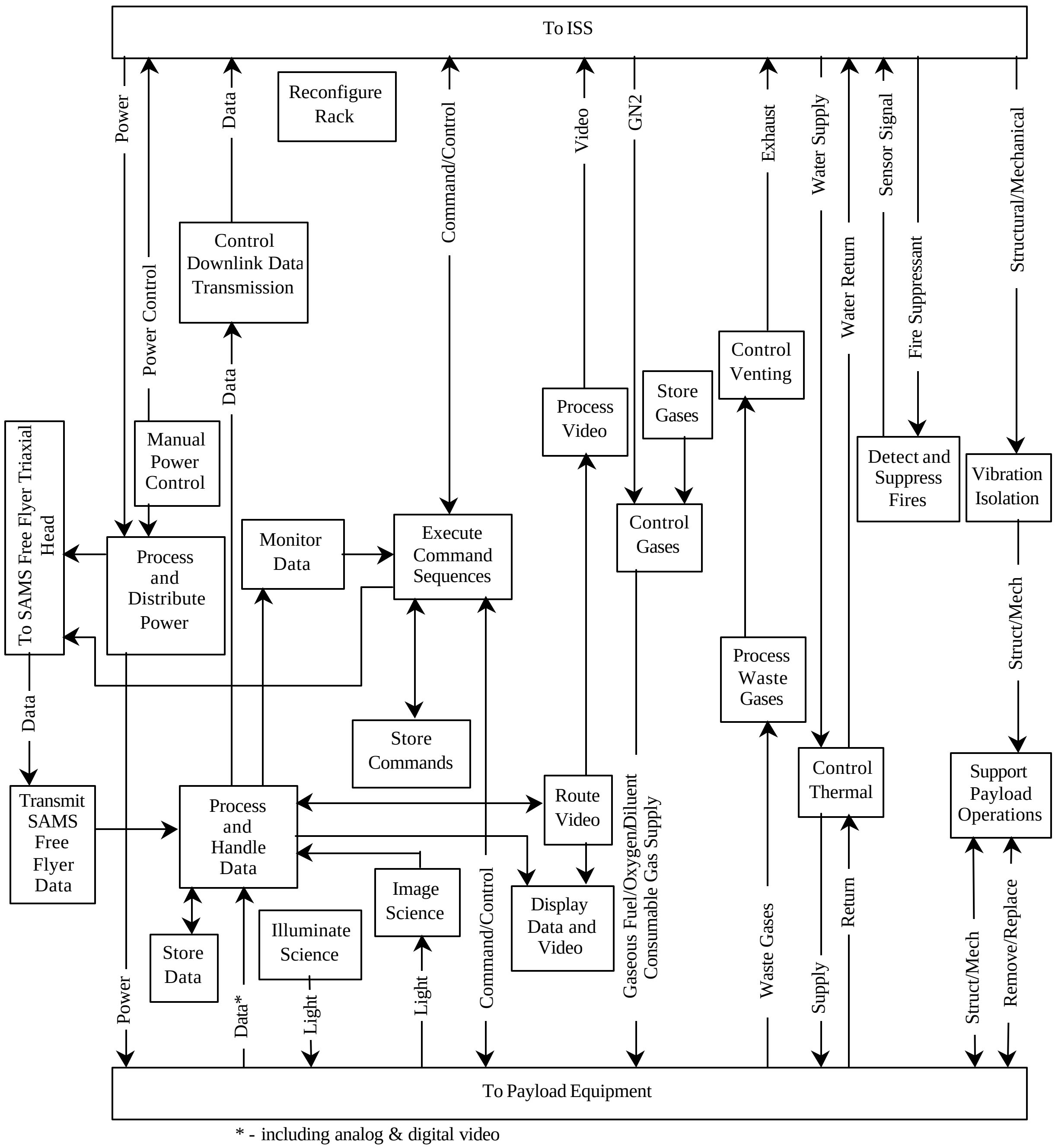


Figure 3. CIR functional schematic

3.1.5 Interfaces.

3.1.5.1 External interfaces.

The external interfaces for the CIR in the launch configuration are the physical attachments of the CIR to the MPLM and are defined in SSP 41017. All assemblies not mounted in the rack will be in stowage containers.

Figure 4 shows the external and experiment interfaces of the CIR to the US Lab. SSP 57007 gives the physical interfaces for the CIR to the US Lab and MPLM. Table I lists the electrical/data interfaces to the US Lab. Table II gives the fluids interfaces connecting the CIR to the US Lab.

Table I. Electrical/data interfaces between CIR and US Lab

Interface	Module Connector	Part Number
Main Power	J1	NATC07T25LN3SN
Essential/Auxiliary Power	J1	NATC07T25LN3SA
1553 Bus A	J3	NATC07T15N35SN
1553 Bus B	J4	NATC07T15N35SA
HDRL	J7	NATC07T13N4SN
Optical Video	J16	NATC07T15N97SB
Fire Detection System/Power Maintenance	J43	NATC07T13N35SA
LAN-1	J46	NATC07T11N35SB
LAN-2	J47	NATC07T11N35SB

Table II. Fluids interfaces used to connect the CIR to the US Lab

Interface	Part Number
Thermal Control System (TCS) Moderate Supply	683-16348, male, Category 6, Keying B
TCS Moderate Return	683-16348, male, Category 6, Keying C
Gaseous Nitrogen	683-16348, male, Category 8, Keying B
Vacuum Exhaust	683-16348, male, Category 3, Keying B

In the event the CIR must be installed into the Columbus Orbital Facility (COF), the CIR will be operated in a degraded condition and will use the interfaces as specified in SSP 57000 for the COF.

3.1.5.2 Internal interfaces.

The internal physical interfaces, PI-specific hardware, and assemblies within the CIR are given in Appendix C. The specific interface descriptions are specified in the respective product specifications. Figure 5 gives the avionics interfaces of the internal assemblies within the CIR. Appendix D lists the electrical/data interfaces for PI-specific hardware and assemblies within the

CIR. Figure 6, Figure 7, and Figure 8 show the CIR internal functional fluids interfaces. The CIR internal gas interfaces are given in Appendix E. Appendix F lists the internal environmental control system interfaces.

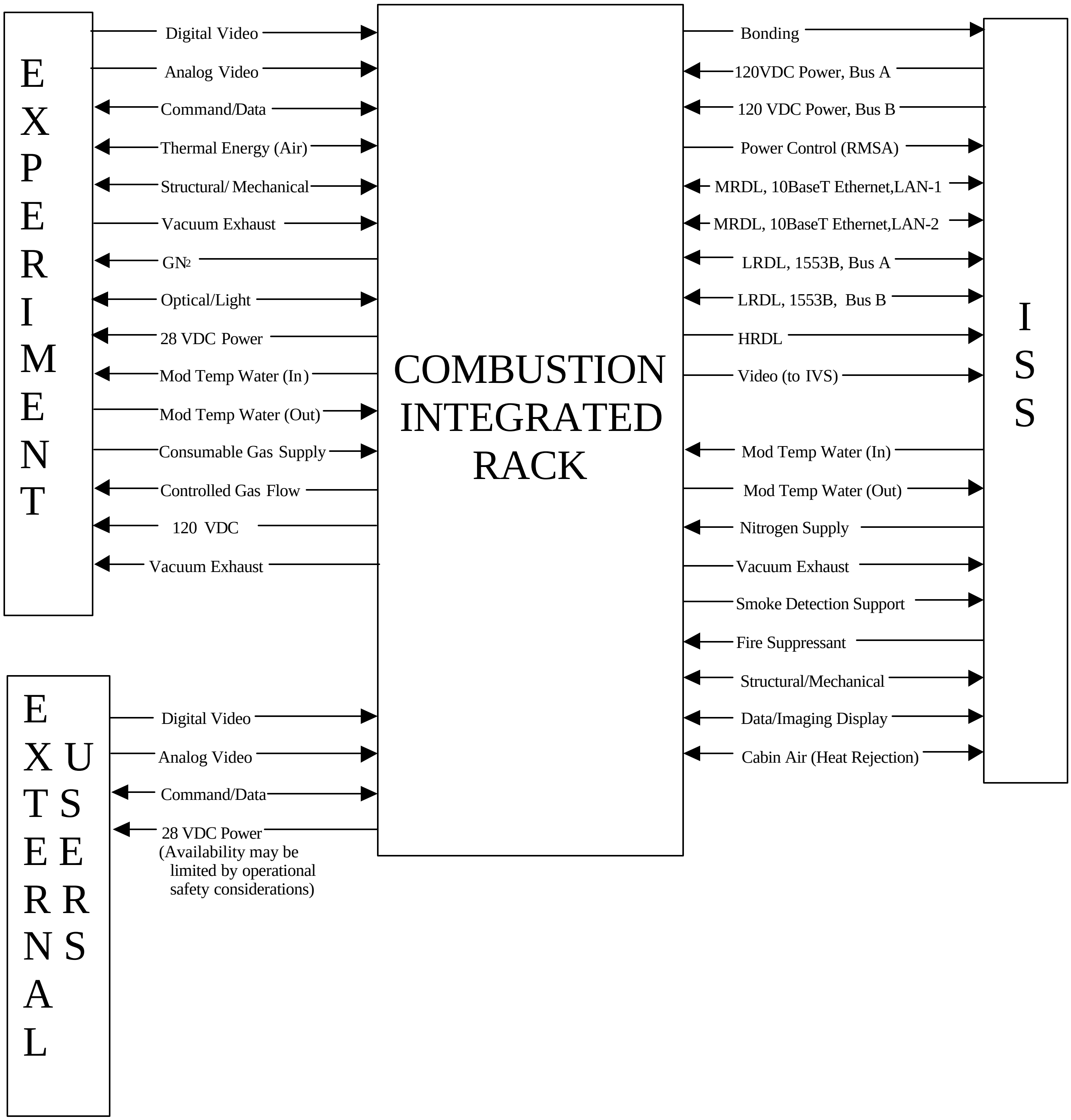


Figure 4. CIR external interface and experiment interface schematic

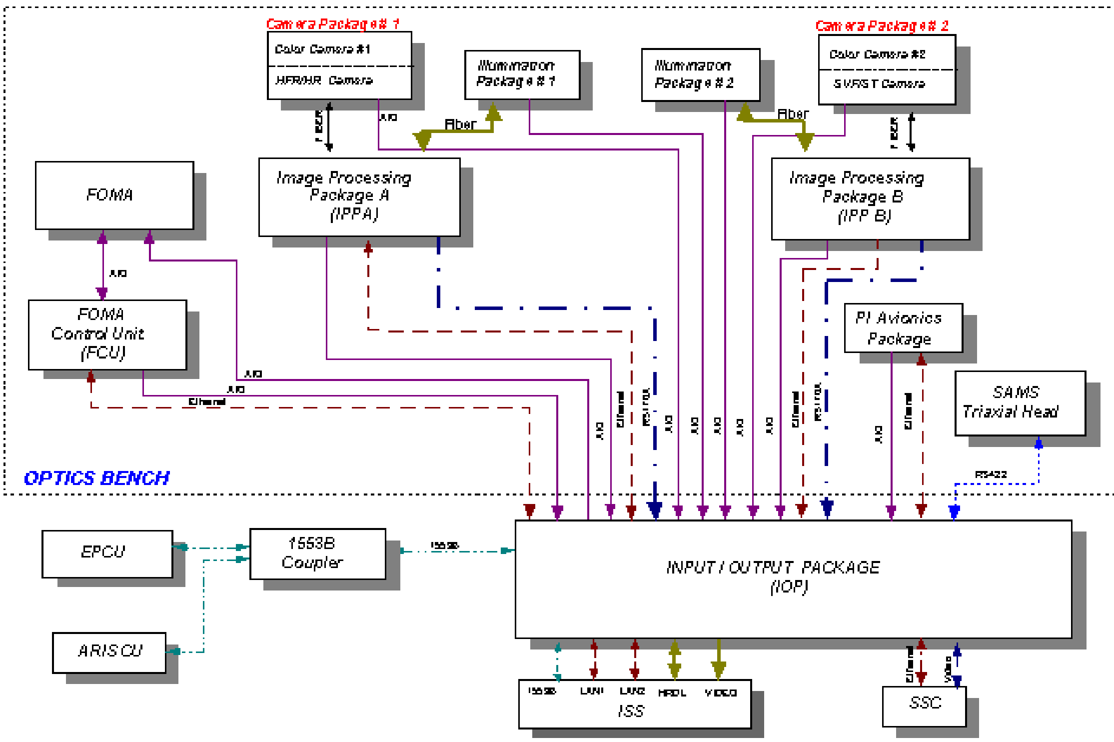


Figure 5. CIR avionics interfaces

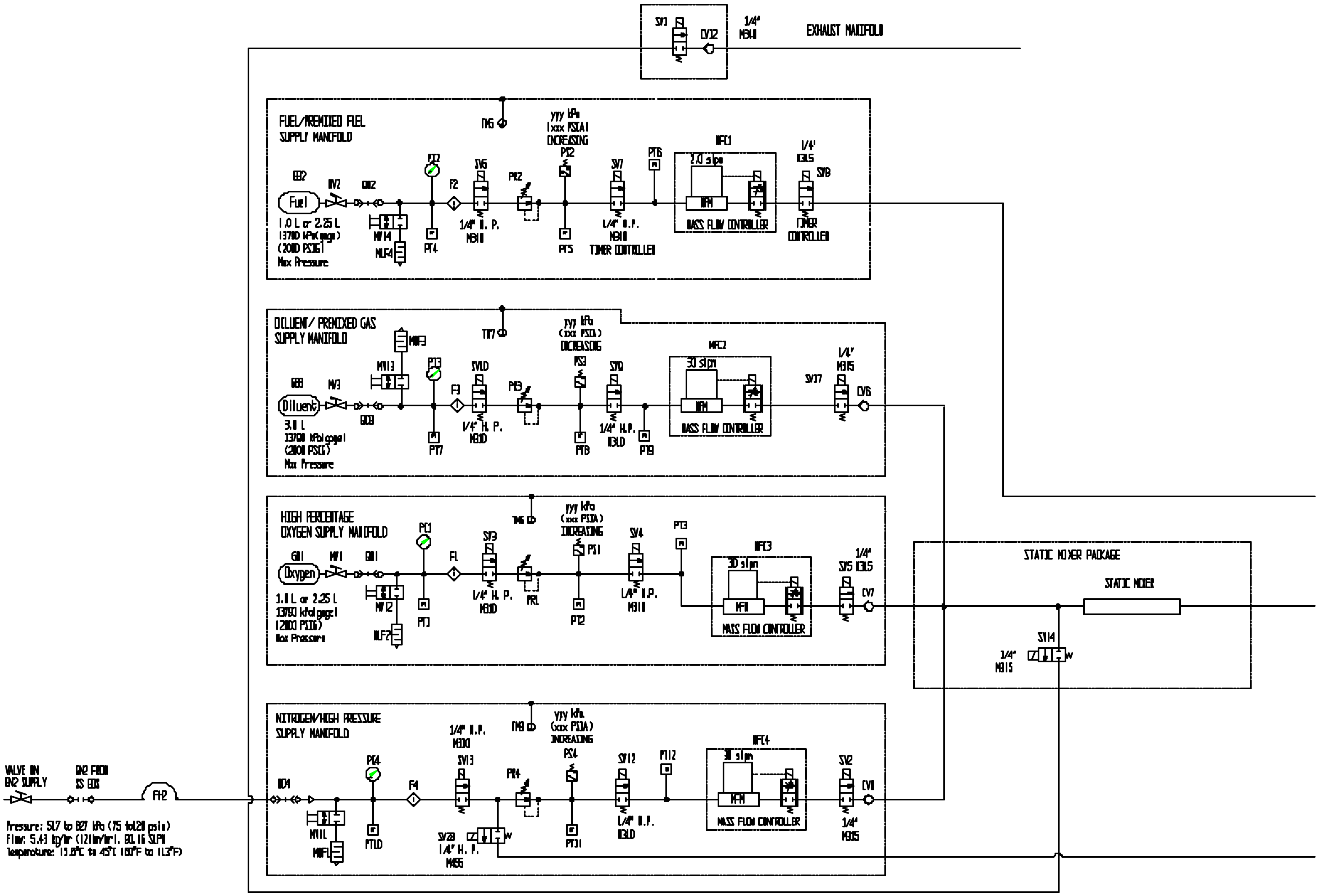


Figure 6. CIR internal functional fluids interfaces

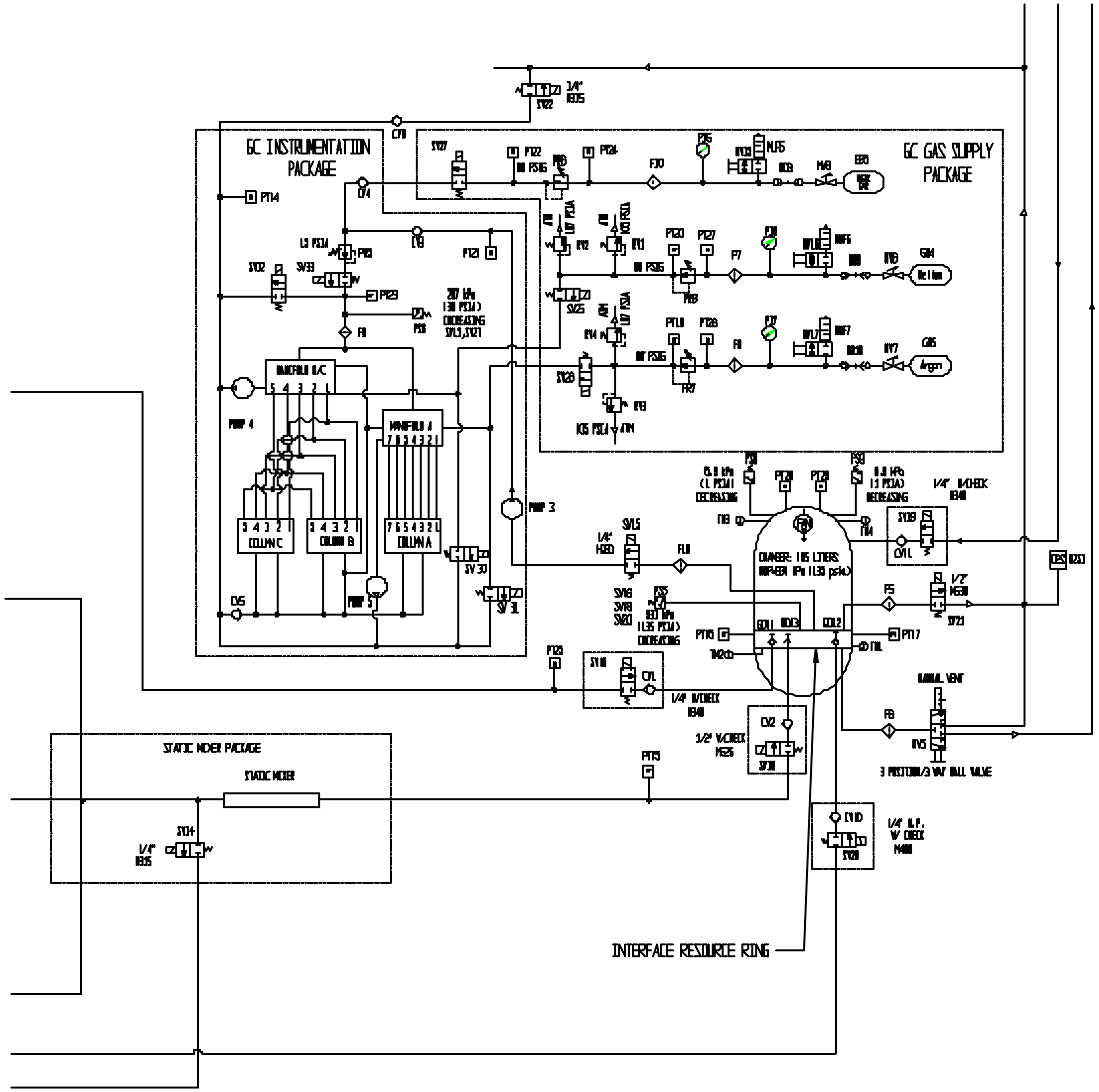


Figure 7. CIR internal functional fluids interfaces – continued

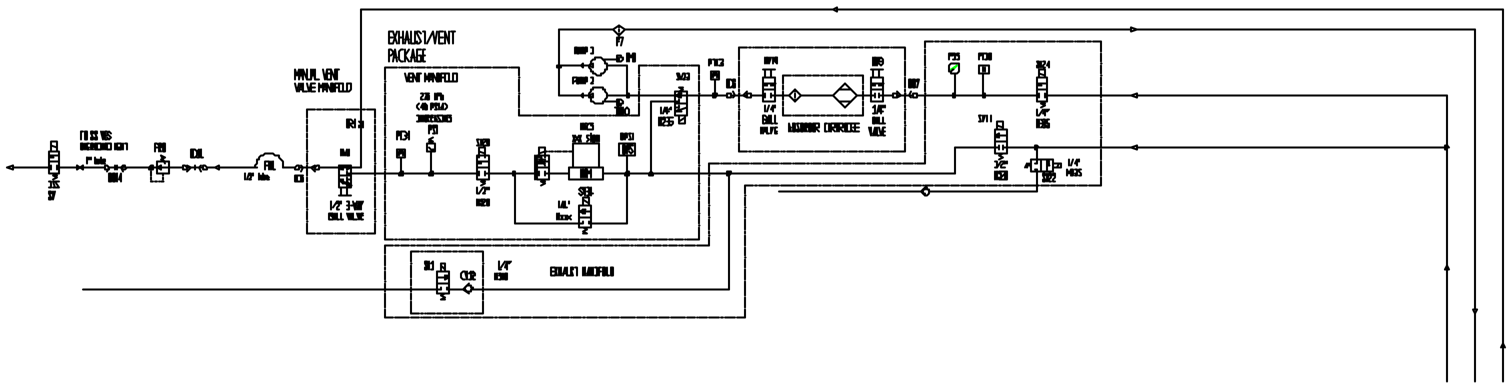


Figure 8. CIR internal functional fluids interfaces - continued

3.1.6 Major components list.

The below list includes the nongovernment furnished major components that describe the CIR:

1. Image Processing Package (IPP) – 67212MFAN17000
2. Input/Output Package (IOP) – 67211MFAB10000
3. CIR Package Assembly – 67212MFAH10000
4. Optic Bench Assembly – 67212MFAH20000
5. Actuator Pin Assembly –67212MFAH21000
6. Removable Handle Assembly – 67212MFAH40000
7. Combustion Chamber Assembly – 67212MFAH30000
8. Linear Hinged Arm Detent Assembly – 67212MFAH31000
9. Interface Resource Ring Assembly – 67212MFAH32000
10. Window Assemblies – 67212MFAH33000
11. Aft End Cap Assembly – 67212MFAH34000
12. Gas Chromatograph (GC) Assembly – 67212MFAM30000
13. FOMA Control Unit (FCU) Assembly – 67212MFAM40000
14. Vent Manifold Assembly – 67212MFAM20000
15. Exhaust Manifold Assembly – 67212MFAM21000
16. Manual Vent Valve Manifold Assembly – 67212MFAM22000
17. Re-circulation Pump Manifold Assembly – 67212MFAM23000
18. Fuel Manifold Assembly – 67212MFAM10000
19. Diluent Manifold Assembly – 67212MALM12000
20. Static Mixer Assembly – 67212MFAM14000
21. Oxygen Manifold Assembly – 67212MFAM11000
22. Nitrogen/High Pressure Manifold Assembly – 67212MFAM13000
23. Bottle Assemblies – 67212MFAM60000
24. Large Adsorber Cartridge Assembly – 67212MFAM61000
25. Adsorber Cartridge Support Bracket Assembly– 67212MFAM24000
26. Small Adsorber Cartridge Assembly – 67212MFAM62000
27. Optics Bench Slide Assembly – 67212MFAG20000
28. Rack Door Closure – 67211MFAG10000
29. Electrical Power Control Unit (EPCU) Rack Attachment– 67211MFAG40000
30. IOP Rack Attachment– 67211MFAG30000
31. Air Thermal Control Assembly (ATCA) – 67211MFAD10000
32. Water Thermal Control System (WTCS) – 67211MFAD20000
33. Gas Interface Assembly – 67211MFAD30000
34. Fire Detection and Suppression Assembly – 67211MFAD40000
35. Color Camera Assembly – 67212MFAN12000
36. Low Light Level – UV Camera Assembly – 67212MFAN14000
37. Low Light Level – IR Camera Assembly – 67212MFAN15000
38. High Frame Rate (HFR)/High Resolution (HR) Camera Assembly -67212MFAN10000
39. High Bit Depth Multispectral (HiBMs) Camera Assembly – 67212MFAN11000
40. Illumination Package Assembly – 67212MFLAN13000
41. Mid Infrared (IR) Camera Assembly – 67212MFAN16000
42. Rack Attachment Plate – 67212MFAH41000

43. Center Post – 67212MFAH42000
44. ATCU Rack Attachment – 67211MFAG50000
45. ARIS Pins – 67211MFAG60000
46. GC Gas Supply Package – Argon – 67212MFAM31000
47. GC Gas Supply Package – Helium – 67212MFAM32000
48. GC Gas Supply Package – Check Gas – 67212MFAM33000

3.1.7 Government furnished property list.

The below list gives the government furnished major components of the CIR:

1. Electrical Power Control Unit (EPCU) – EP4001-9
2. Spacecraft Acceleration Measurement System (SAMS) Free Flyer – 60005MA12100

3.1.8 Government loaned property list.

Not applicable.

3.1.9 Program furnished property list.

The below list gives the program furnished major components of the CIR:

1. International Standard Payload Rack (ISPR) – 683-50243
2. Active Rack Isolation System (ARIS) – 683-61600

3.2 Characteristics.

3.2.1 Performance characteristics.

The CIR shall meet the performance characteristics requirements as specified herein from the requirements in FCF-DOC-002 and FCF-SPC-0001 allocated as specified in FCF-DOC-004 Chapter 2.

3.2.1.1 Utilization.

The CIR, with applicable PI hardware and resources, shall be designed to support 10 combustion experiments per year.

3.2.1.1.1 Minimum utilization.

The CIR, with applicable PI hardware and resources, shall be designed to support a minimum utilization of five combustion basis experiments as specified in FCF-DOC-002.

3.2.1.1.2 Additional utilization.

The CIR, with applicable hardware and resources, shall be capable of accommodating a minimum of five additional combustion experiments from commercial and/or international sources.

3.2.1.1.3 Utilization capacity.

The CIR, with applicable PI hardware and resources, shall be designed to meet a minimum of 80% of the proposed combustion experiments based on using the combustion basis experiments as specified in FCF-DOC-002 for the CIR design.

3.2.1.1.3.1 Basis experiment capacity.

The CIR, with applicable PI hardware and resources, shall be designed to meet a minimum of 80% of the combustion basis experiments' current/historical Science Requirements Document (SRD) test matrices using the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.1.3.2 Initial scheduled experiment capacity.

TBD.

3.2.1.2 Combustion chamber science volume.

The CIR combustion chamber science volume, including applicable hardware to meet a minimum of 80% of the proposed science within the chamber, shall have a minimum volume of 100 liters.

3.2.1.3 Combustion chamber science width.

The CIR combustion chamber internal minimum width shall be no less than 45 cm.

3.2.1.4 Combustion chamber internal cleanliness.

3.2.1.4.1 Initial combustion chamber internal cleanliness.

The initial CIR combustion chamber internal cleanliness shall be maintained Visibly Clean – Sensitive (VC – S) from the time of shipment to the launch facility until the CIR is set up for its first experiment.

3.2.1.4.2 Combustion chamber cleanliness on orbit.

The CIR combustion chamber internal cleanliness on orbit shall be maintained to meet the optical science requirements as specified in FCF-DOC-002.

3.2.1.5 Fuel/oxidizer storage.

The CIR, with the applicable PI hardware and resources, shall be designed to accommodate gaseous, liquid and solid fuels, oxidizers, and diluents.

3.2.1.6 Gas distribution.

The CIR shall provide for delivery of gases used in the basis experiments as specified in FCF-DOC-002 to the combustion chamber.

3.2.1.7 Gas mixing.

The CIR shall be designed to provide mixing of gases to perform the basis experiments as specified in FCF-DOC-002.

3.2.1.8 Ignition interface.

The CIR shall provide to the PI-specific combustion chamber hardware at least one interface capable of supplying power and controls for igniting fuel/oxidizer mixtures based on the basis experiments' power and control requirements as specified in FCF-DOC-002.

3.2.1.9 Science acceleration and vibration.

The CIR shall maintain an acceleration and vibration environment as shown in

Figure 9 during the operation of the basis experiments' test points as specified in FCF-DOC-002.

3.2.1.10 Initial combustion chamber pressure.

The CIR combustion chamber shall be designed to provide initial pressure containment and control from 0.02 to 3 atm (± 5% for any measurement within the range).

3.2.1.11 Containment pressure.

The CIR, including applicable PI hardware, shall be designed to contain a minimum pressure of 9 atm.

3.2.1.12 Initial gas temperatures.

The CIR, with applicable PI hardware, shall be designed to control initial temperatures of gases within the combustion chamber from 268 to 320 K.

3.2.1.13 Condensed phase fuel temperatures.

The CIR, shall be designed to control condensed phase fuel temperatures of gases within the combustion chamber from 268 to 315 K (± 1 K for any measurement within the range).

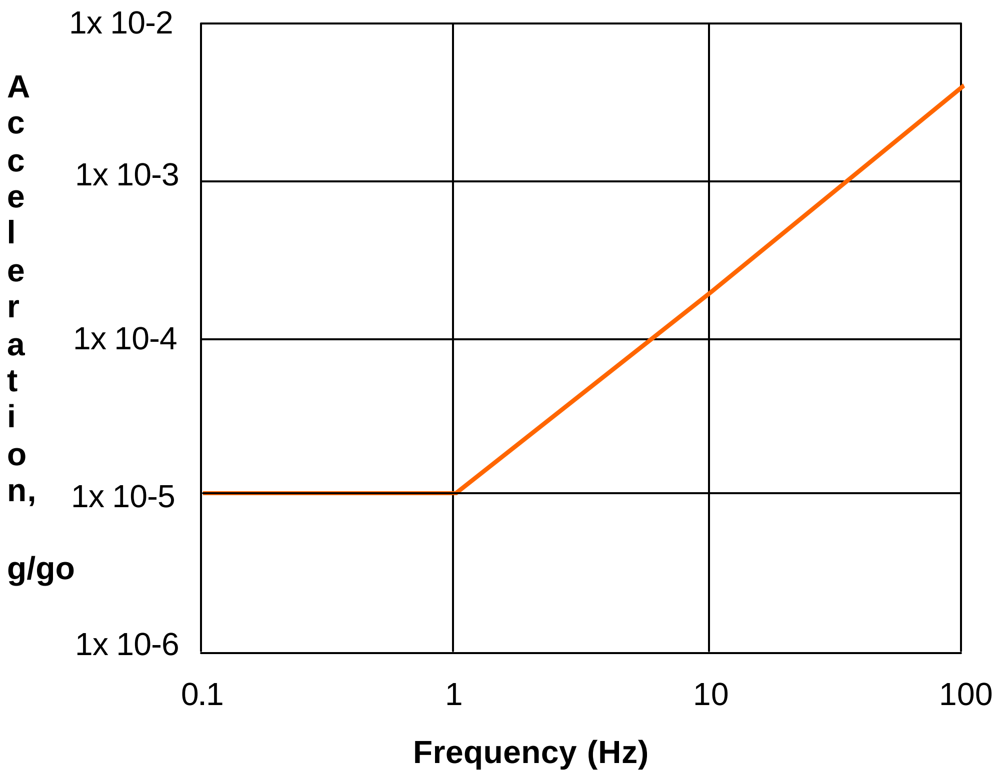


Figure 9. Acceptable minimum CIR acceleration and vibration levels

3.2.1.14 Science oxygen compatibility.

The CIR internal gas supply system, Gas Chromatograph, combustion chamber, and exhaust vent hardware shall be compatible with oxygen at a concentration no less than 70% in accordance with the accuracy ranges specified in FCF-DOC-002.

3.2.1.15 Gas blending.

The CIR shall be designed to provide gas blending capability of oxidizer with diluents from 0 to 70% (± 0.5% for any measurement within the range) oxidizer concentration.

3.2.1.16 Premixed gases.

The CIR shall be designed to dispense premixed gases from gas bottles designed to the interface requirements as specified in each basis experiment.

3.2.1.17 Gaseous fuel flow.

The CIR shall be designed to control gaseous fuel flow from 0 to 30 scc/s (± 5% for any measurement within the range) of the set point.

3.2.1.18 Gaseous oxidizer/diluent flow.

The CIR, with applicable PI hardware, shall be designed to control gaseous oxidizer/diluent flow from 0 to 4,000 scc/s (± 5% for any measurement within the range) of the set point.

3.2.1.19 Test point durations.

The CIR, with applicable PI hardware, shall be designed to support test point durations of no less than 8,000 s in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.20 Number of test points.

The CIR, with applicable PI hardware, shall be designed to accommodate no less than 70 test points in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.21 Visible imaging.

The CIR shall be designed to provide visible imaging capability from wavelengths of 400 to 700 nm.

3.2.1.21.1 Visible imaging framing rate.

The CIR shall be designed to provide a visible image framing rate of at least 100 frames/s in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.21.2 Visible imaging resolution.

The CIR visible imaging capability shall have a resolution from 0.018 to 5 mm at a minimum measurable contrast level, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.21.3 Visible imaging field of view.

The CIR visual imaging capability shall have a field of view from 1.9 to 1,000 cm^2 ± 10%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.21.4 Visible imaging depth of field.

The CIR visual imaging capability shall have a depth of field from 0.5 to 35 cm ± 20%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.21.5 Visible imaging lateral/axial field of view.

The CIR visual imaging capability, with the applicable PI hardware, shall have a lateral field of view from 0.9 to 35 cm ± 10% in association with an axial field of view from 1.9 to 35 cm ± 10%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.21.6 Visible imaging illumination.

The CIR shall be designed to provide illumination sources in a minimum spectral range from wavelengths of 400 to 700 nm.

3.2.1.22 Infrared (IR) imaging.

The CIR, with applicable PI hardware, shall provide IR imaging capability in the spectral ranges from 1,000 to 5,000 nm and from 8,000 to 14, 000 nm.

3.2.1.22.1 IR imaging framing rate.

The CIR IR imaging capability shall have a framing rate of at least 60 frames/s.

3.2.1.22.2 IR imaging field of view.

The CIR IR imaging capability shall have a field of view from 2 to 1,000 cm^2 ± 10%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.22.3 IR imaging depth of field.

The CIR IR imaging capability shall have a depth of field from 0.1 to 35 cm ± 20%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.22.4 IR imaging lateral/axial field of view.

The CIR IR imaging capability, with the applicable PI hardware, shall have a lateral field of view from 1 to 35 cm ± 10% in association with an axial field of view from 2 to 35 cm ± 10%.

3.2.1.23 Ultraviolet (UV) imaging.

The CIR shall provide a UV imaging capability from wavelengths of 250 to 400 nm.

3.2.1.23.1 UV imaging framing rate.

The UV imaging capability shall have a framing rate of at least 100 frames/s.

3.2.1.23.2 UV imaging resolution.

The CIR UV imaging capability shall have a resolution from 0.09 to 2.5 mm at the minimum measurable contrast level, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.23.3 UV imaging field of view.

The CIR UV imaging capability shall have a field of view from 1.9 to 200 cm^2 ±10% in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.23.4 UV imaging depth of field.

The CIR UV imaging capability shall have a depth of field from 0.5 to 5.1 cm ± 20%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.23.5 UV imaging lateral/axial field of view.

The CIR UV imaging capability, with the applicable PI hardware, shall have a lateral field of view from 0.9 to 12 cm ± 10% in association with an axial field of view from 1.9 to 20 cm ± 10%, in accordance with the combustion basis experiments as specified in FCF-DOC-002.

3.2.1.24 Gas phase temperature point measurements.

The CIR, with applicable PI hardware, shall be capable of obtaining gas phase temperature point measurements in 12 separate locations at selectable measurement rates from 0 to 1,000 measurements/s/measurement location.

3.2.1.24.1 Gas phase temperature point measurement range.

The CIR, with applicable PI hardware, shall be capable of measuring gas phase temperature points from 280 to 2,000 K per the accuracy requirements of the basis experiments as specified in FCF-DOC-002.

3.2.1.25 Condensed phase temperature point measurements.

The CIR, with applicable PI hardware, shall be capable of obtaining condensed phase temperature point measurements in 20 separate locations at selectable measurement rates from 0 to 30 measurements/s/measurement location.

3.2.1.25.1 Condensed phase temperature point measurement range.

The CIR, with applicable PI hardware, shall be capable of measuring gas phase temperature points from 200 to 1,100 K per the accuracy requirements of the basis experiments as specified in FCF-DOC-002.

3.2.1.26 Gas phase temperature field measurements.

The CIR, with applicable PI hardware, shall be designed to provide gas phase temperature field measurements from 280 to 2,000 K with temperature resolution requirements per the basis experiments as specified in FCF-DOC-002.

3.2.1.26.1 Gas phase temperature field measurement sampling rate.

The CIR, with applicable PI hardware, shall be designed to provide a gas phase temperature field measurement sampling rate of at least 60 measurements/s.

3.2.1.26.2 Gas phase temperature field measurement spatial resolution.

The CIR, with applicable PI hardware, shall be designed to provide a gas phase temperature field measurement resolution from 0.08 to 2 mm at the minimum measurable contrast level.

3.2.1.26.3 Gas phase temperature field measurement lateral/axial field of view.

The CIR, with applicable PI hardware, shall be capable of providing a gas phase temperature field measurement lateral field of view from 2.9 to 20 cm ± 10% associated with an axial field of view from 0.5 to 35 cm ± 10%.

3.2.1.27 Condensed phase temperature field measurements.

The CIR, with applicable PI hardware, shall be designed to provide condensed phase temperature field measurements from 260 to 1,300 K with temperature resolution requirements per the basis experiments as specified in FCF-DOC-002.

3.2.1.27.1 Condensed phase temperature field measurement sampling rate.

The CIR, with applicable PI hardware, shall be designed to provide a condensed phase temperature field measurement sampling rate of at least 60 measurements/s.

3.2.1.27.2 Condensed phase temperature field measurement spatial resolution.

The CIR, with applicable PI hardware, shall be designed to provide a condensed phase temperature field measurement resolution from 0.2 to 0.5 mm at the minimum measurable contrast level.

3.2.1.27.3 Condensed phase temperature field measurement lateral/axial field of view.

The CIR, with applicable PI hardware, shall be capable of providing a condensed phase temperature field measurement lateral field of view from 2.8 to 12 cm associated with an axial field of view from 5 to 20 ± 10%.

3.2.1.28 Pressure measurements.

The CIR, with applicable PI hardware, shall be capable of measuring pressures inside the combustion chamber from at least four separate locations.

3.2.1.28.1 Pressure measurement sampling rate.

The CIR, with the applicable PI hardware, shall be capable of selecting pressure measurement sampling rates from 0 to 1,000 measurements/s.

3.2.1.28.2 Pressure measurement range.

The CIR, with applicable PI hardware, shall be capable of measuring pressures from 0.0001 to 8 atm with the accuracy requirements described in the basis experiments as specified in FCF-DOC-002.

3.2.1.29 Chemical composition measurements.

The CIR, with the applicable PI hardware, shall be capable of sampling and measuring gases from the combustion chamber.

3.2.1.29.1 Chemical composition measurement constituents.

The CIR, with the applicable PI hardware, shall be capable of measuring, as a minimum, the following compounds:

a. Hydrogen
b. Methane

c. Propane
d. Oxygen
e. Nitrogen
f. Carbon monoxide
g. Carbon dioxide
h. Sulfur hexafluoride
i. Water

3.2.1.29.2 Gas composition measurement range.

The CIR, with the applicable PI hardware, shall be capable of measuring the gas constituents in a range from 0.1 to 100% (± 2% for any measurement within the range) of the measured concentration.

3.2.1.30 Soot measurements.

The CIR, with the applicable PI hardware, shall be capable of collecting a minimum of two soot samples from at least four separate locations.

3.2.1.30.1 Soot volume fraction measurement lateral/axial field of view.

The CIR, with applicable PI hardware, shall provide a lateral field of view from 2.5 to 4 cm with an axial field of view from 0.03 to 10 cm ± 10%.

3.2.1.30.2 Soot volume fraction measurement resolution.

The CIR, with applicable PI hardware, shall provide a lateral resolution from 0.1 to 3 mm ± 10% with an axial resolution from 0.1 to 1 mm ± 10%.

3.2.1.31 Radiometry measurements.

The CIR, with applicable PI hardware, shall provide at least five channels for radiometry measurement from wavelengths of 200 to 40,000 nm.

3.2.1.31.1 Radiometry measurement sampling rates.

The CIR, with applicable PI hardware, shall be capable of sampling radiometry measurements from 0 to 1,000 measurements/s.

3.2.1.32 Velocity point measurements.

The CIR, with applicable PI hardware, shall be capable of obtaining velocity point measurements from at least 20 separate locations.

3.2.1.32.1 Velocity point measurement sampling rate.

The CIR, with applicable PI hardware, shall be capable of sampling from velocity point measurements from 2 to 1,000 measurements/s.

3.2.1.32.2 Velocity point measurement velocity range.

The CIR, with applicable PI hardware, shall be capable of measuring velocities from 0.5 to 5,000 cm/s at the accuracy requirements of the basis experiments as specified in FCF-DOC-002.

3.2.1.33 Full field velocity imaging.

The CIR, with applicable PI hardware, shall be capable of full field velocity imaging with a lateral field of view from 2 to 12 cm in association with an axial field of view from 2 to 14 cm (± 0.5 cm for any measurement within the range).

3.2.1.33.1 Full field velocity imaging framing rate.

The CIR, with applicable PI hardware, shall be capable of full field velocity measurements at a framing rate from 30 to 60 frames/s.

3.2.1.34 Acceleration measurements.

The CIR shall be capable of monitoring residual accelerations and g-jitter from 10^{-6} to 10^{-2} g/g_0 with an accuracy range as defined in the basis experiments as specified in FCF-DOC-002.

3.2.1.34.1 Acceleration measurement sampling rate.

The CIR shall be capable of measuring the accelerations at a sampling rate from 1 to 1,000 measurements/s.

3.2.1.35 Data time reference.

The CIR, with applicable PI hardware, shall be capable of referencing all data, including digital images, to ISS-related mission time.

3.2.1.35.1 Data time reference for experiment events.

The CIR, with applicable PI hardware, shall be designed to have a time reference resolution of ± 0.001 s for experiment events.

3.2.1.35.2 Data time reference for external events.

The CIR, with applicable PI hardware, shall be designed to have a time reference resolution of ± 1 s for external events.

3.2.1.36 Simultaneous measurements.

The CIR, with applicable PI hardware, shall be capable of simultaneously providing up to 8 field measurements and up to 35 single sensor measurements inside and outside the combustion chamber with required controls to operate the basis experiments as specified in FCF-DOC-002.

3.2.1.37 On orbit instrument calibration.

The CIR shall be capable of performing on orbit calibrations of instruments using standards traceable to the National Institute of Standards and Technology (NIST).

3.2.1.37.1 Replacement of on orbit instruments.

The CIR instrument hardware not capable of being calibrated on orbit shall be designed to be replaced with instruments calibrated to standards traceable to NIST.

3.2.1.38 Rack environment monitoring.

The CIR shall be designed to monitor the pressure, temperature, humidity, and acceleration within the CIR rack environment.

3.2.1.39 On orbit data storage.

The CIR, with applicable PI hardware and software, shall be capable of identifying all on orbit data as specified in paragraphs 3.2.1.19 and 3.2.1.20 based on the basis experiments as specified in FCF-DOC-002.

3.2.1.40 On orbit data collection and transfer.

3.2.1.40.1 Processing and providing data.

a. The CIR shall be capable of interfacing with the ISS to allow all on orbit data transfer for downlinking to the ground for use by the payload equipment and FCF ground crews and for data archiving prior to SAR deployment.

b. After SAR deployment, the CIR shall acquire, synthesize, and transfer science performance, configuration, status assessment, and message data to the SAR.

c. Prior to deployment of the SAR, during stand-alone operations, and in case of loss of the SAR to ISS communications, the CIR shall acquire, synthesize, and present science, performance, configuration, status assessment, and message data to the on orbit crew in the form of textual and graphic displays to the SSC.

d. Prior to SAR deployment and within the limited volume provided for image processing, the CIR shall be capable of processing scientific and engineering data in order to reduce the real-time, near real-time, and post-test bandwidth and duration necessary to transmit the data to the ground though the ISS. This processing should allow for (1) limiting the data streams though selection of duration and downlink sample rates by the FCF ground operations and payload equipment operation teams, for all data streams (2) downlinking data only when it is above, below, between, or outside a certain value(s) selected by the FCF ground operations and payload equipment operation teams, and (3) mission specific compression or data manipulation software code to be run. Note that this does not require the mission specific software code to be developed, only the capability to run such code when it is developed.

e. The CIR shall retain all data until commands are received from the FCF ground operations team indicating what data can be deleted or over-written.

f. The CIR shall be capable of providing, when requested by the FCF ground operations team, a summary of all data stored in the CIR, including identification of each measurement, time stamp/duration of data for each measurement, and file sizes.

g. The CIR shall be capable of sending image streams from scientific imaging devices in the CIR to the SAR for image processing and storage.

3.2.1.40.2 On orbit data transfer within FCF.

The CIR shall be capable of accepting and transferring all data to the SAR at a minimum rate of 100 Mbits/s after SAR deployment.

3.2.1.40.3 Use of fiber optics.

The CIR shall use fiber optics for transferring all digital image data and inter-rack communications.

3.2.1.40.4 On orbit data transfer to portable media.

The CIR shall be capable of transferring all stored data, as specified in paragraphs 3.2.1.19 and 3.2.1.20 based on the basis experiments as specified in FCF-DOC-002, to portable media.

3.2.1.41 CIR health status monitoring.

The CIR, with applicable PI hardware and software, shall be designed to monitor and transfer on orbit health status data of all assemblies with electrical and fluids interfaces to the Station Support Computer (SSC) and to the SAR and to transfer on orbit health status data to the ISS for downlinking when the CIR is powered and note any out-of-tolerance conditions.

3.2.1.41.1 CIR/FCF health status monitoring.

The CIR shall have the capability to interface with the SSC, to transfer to the SSC health status data of FCF systems that interface with the CIR, and to transfer the health status data to the ISS for downlinking when the CIR is powered and note any out-of-tolerance conditions.

3.2.1.41.1.1 Health status reporting to SAR.

The CIR shall report all out-of-tolerance conditions to the SAR after SAR deployment.

3.2.1.41.2 CIR/ISS health status monitoring.

The CIR shall have the capability to interface with the SCC, to transfer to the SCC its health status data of ISS systems that interface with the CIR, and to transfer the health status data to the ISS for downlinking when the CIR is powered and note any out-of-tolerance conditions.

3.2.1.42 CIR Commanding.

3.2.1.42.1 SSC Commanding.

The CIR, with applicable PI hardware and software, shall be capable of accepting command inputs, acknowledging and validating the inputs, returning responses, and monitoring all CIR functions that use the SSC when the CIR is powered.

3.2.1.42.2 Ground Commanding.

The CIR, with applicable PI hardware and software, shall be capable of accepting command inputs, acknowledging and validating the inputs, and returning responses though the ISS-provided interfaces when the CIR is powered.

3.2.1.42.3 Commanding though SAR.

The CIR, with applicable PI hardware and software, shall be capable of accepting command inputs, acknowledging and validating the inputs, and returning responses using the SAR when the CIR is powered.

3.2.1.42.4 Manual Inputs

The CIR shall provide the mechanical (switches, displays, etc.) equipment necessary for the on orbit crew to control the CIR.

3.2.1.43 Upgrading of CIR maintenance items.

The CIR shall be designed to allow for upgrading of components within the assemblies and other maintenance items within the CIR.

3.2.1.44 Use of FIR capabilities.

The CIR shall investigate the use of FIR capabilities to meet science and project requirements.

3.2.1.45 Control of CIR.

a. The CIR shall provide overall control as specified in Table III.

Table III. Control conditions

Capability	Control Conditions
Perform/support combustion science	Capability is not required to be continuous. Initiation of capability shall be though ground or on orbit crew command.
Process and provide data	Capability is not required to be continuous. Initiation of capability shall be though automated sequence or ground or on orbit crew command.
Respond to out-of-tolerance conditions	Capability is required to be continuous, whenever powered.
Withstand external environment changes	Capability is required to be continuous.
Accept commanding and manual inputs	Capability is required to be continuous, whenever powered.
Maintenance/troubleshooting	Capability is not required to be continuous. Initiation of capability shall be though ground or on orbit crew command or on orbit crew operation.
Reconfigure CIR	Capability is not required to be continuous. Initiation of capability shall be though ground or on orbit crew command for software and on orbit crew operation for hardware.

b. The CIR shall control all payload equipment placed within the CIR.

3.2.2 Physical characteristics.

3.2.2.1 CIR dimensional characteristics.

3.2.2.1.1 CIR launch envelope.

The CIR in launch configuration shall not exceed the envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2.

3.2.2.1.2 CIR on orbit envelope.

The CIR, with applicable PI hardware, shall have an on orbit envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2 and shall follow the on orbit payload protrusion requirements as specified in SSP 57000, paragraph 3.1.1.7. (See Appendix H for exceptions to this requirement.)

3.2.2.1.3 CIR stowage volume.

a. The CIR, with applicable PI hardware, shall not exceed a stowage volume of 1 standard rack equivalent.

b. The CIR shall provide a minimum of 0.45 m^3 of space for payload equipment within its envelope with an additional 0.60 m^3 of optionally available for use by payloads if they do not require Flight Segment provided diagnostics.

3.2.2.1.4 CIR maintenance item stowage.

The CIR maintenance items shall not exceed a volume of 1/3 standard rack equivalents.

3.2.2.2 CIR weight characteristics.

a. The CIR shall not exceed a launch mass of 804.2 kg (1773 lbs), excluding stowage hardware.
b. The CIR, with applicable PI hardware, shall not exceed an on orbit mass of 804.2 kg (1773 lbs), excluding stowage hardware. (See Appendix H for exceptions to this requirement.)
c. CIR spares and resupply equipment shall not exceed an up-mass of 125 kg (275 lbs).

3.2.2.3 CIR power.

a. The CIR, with applicable PI hardware, shall have the capability to use a maximum of 6,000 W of power.
b. The CIR, with applicable PI hardware, when integrated into the FCF, shall not exceed a power draw of 2,000 W.

3.2.2.3.1 CIR environmental control system power allocation.

The CIR environmental control system power allocation shall not exceed, over a period of 30 minutes, 30 W or 8% of the input power to the CIR, whichever is greater.

3.2.2.3.2 CIR power to PI avionics.

The CIR shall provide a minimum of 2 channels of 8A, 28 Vdc power for PI avionics.

3.2.2.3.3 CIR power to PI hardware inside combustion chamber.

The CIR shall provide 3 channels 4A, 120 Vdc and 2 channels 8A, 28 Vdc power to operate experiments within the combustion chamber.

3.2.2.4 CIR heat rejection.

The CIR shall have the capability to reject a maximum of 6,000 W of power.

3.2.2.5 PI avionics cooling air.

The CIR shall provide a minimum of 450 W air cooling to PI avionics.

3.2.2.6 Thermal cooling water.

The CIR, with applicable PI hardware, shall be capable of providing thermal water cooling with a minimum inlet temperature of 16.1°C (61.0°F) and a maximum outlet temperature of 48.9°C (120°F).

3.2.2.6.1 Thermal water cooling inside combustion chamber.

The CIR, with applicable PI hardware, shall be capable of providing thermal water cooling to the interior of the combustion chamber at a minimum of 500 W capacity with a minimum inlet temperature of 16°C (60.8°F) and a maximum outlet temperature of 49°C (120°F).

3.2.2.7 Durability.

a. The CIR shall be designed to have a minimum operational life of 10 years after full deployment of the FCF, including regularly scheduled and unscheduled maintenance activities.
b. The CIR shall be designed to be capable of an extended life to 15 years after full deployment, including regularly scheduled and unscheduled maintenance activities and major component replacement.

3.2.2.8 Transportation and safety requirements.

This paragraph is covered in paragraph 3.2.7 and section 5.0.

3.2.2.9 Interfaces.

The CIR, with applicable PI hardware, shall interface with the ISS and CIR internal assemblies in accordance with paragraph 3.1.5.

3.2.2.9.1 Ground support equipment (GSE) interfaces.

a. The CIR shall interface to the Kennedy Space Center (KSC) GSE Rack Insertion Device in accordance with SSP 41017 Part 1, paragraphs 3.2.1.1.2 and 3.2.1.4.3 and SSP 41017 Part 2, paragraphs 3.3.2 and 3.3.3.
b. The CIR shall interface to Rack Shipping Containers in accordance with the Teledyne Brown Engineering (TBE) as-built drawing 220G07500.
c. The CIR shall interface to Rack Handling Adapters (RHA) in accordance with the following TBE as-built drawings: 220G07455, 220G07470, and 220G07475.
d. The CIR shall be limited to ground transportation accelerations of 80% of flight accelerations defined by SSP 41017 Part 1, paragraph 3.2.1.4.2.

3.2.2.9.2 MPLM interfaces.

a. The CIR shall interface to the MPLM structural attach points in accordance with SSP 41017 Part 2, paragraph 3.1.1.

b. The CIR shall maintain positive margins of safety for MPLM depress rates of 890 Pa/s (7.75 psi/min) and repress rates of 800 Pa/s (6.96 psi/min).
c. The CIR shall be limited to producing interface attach point loads less than or equal to those identified by SSP 41017 Part 1, paragraph 3.2.1.4.3, based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2.

3.2.2.9.3 COF interfaces.

The CIR shall be capable of interfacing with the COF for structural, fluids, and electrical connections, but shall not be required to meet any of the performance requirements and physical requirements unless otherwise specified in SSP 57000.

3.2.3 Reliability.

Not applicable.

3.2.4 Maintainability.

The CIR shall not exceed TBD on orbit mean maintenance crew hours per year (MMCH/Y) for scheduled and unscheduled maintenance activities including inspections, preventative and corrective maintenance, restorations, and replacement of assemblies and components.

3.2.4.1 CIR maintenance access.

The CIR shall be designed to allow for the replacement of Orbital Replacement Units (ORU's) and failed components and the performance of other internal maintenance activities without rotating the CIR from its installed position within the US Lab. (See Appendix H for exceptions to this requirement.)

3.2.4.2 Maintenance item temporary restraint and stowage.

CIR maintenance items shall be designed to allow for temporary restraint and/or stowage during maintenance activities.

3.2.4.3 Tool usage for maintenance.

The CIR shall be designed to be maintained using the ISS tools as defined in SSP 57020.

3.2.4.4 Lockwiring and staking.

All CIR maintenance items shall not be lockwired or staked during installation.

3.2.4.5 Redundant paths.

The CIR, with applicable PI hardware, shall be designed to provide for alternate or redundant functional paths of all electrical and electronic harnesses that cannot be replaced on orbit.

3.2.4.6 CIR reconfiguration for out-of-tolerance conditions.

The CIR, with applicable PI hardware, shall be designed to allow visual and tactile access to all avionics hardware for at least one hour during troubleshooting operations without detrimental effects to the crew, the ISS, or CIR hardware.

3.2.5 Availability.

The CIR, with applicable PI hardware and spares, shall have an operational availability of 92.92% for a base operational life of 10 years with an extendable capability to 15 years in accordance with the formula:

A_0 = MTBM/MTBM+MDT

Where MTBM = Mean Time Between Maintenance and MDT = Mean Delay Time.

3.2.6 Environmental conditions.

3.2.6.1 Shipping and storage environment.

3.2.6.1.1 Nonoperating atmospheric environment.

a. The CIR shall be designed to have a nonoperating temperature range from 2 to 50°C (35.6 to 122°F).
b. The CIR shall be designed to have a nonoperating pressure range from 0 to 104.8 kPa.
c. The CIR shall be designed to tolerate a relative humidity range from 10 to 90%.

3.2.6.2 MPLM/on orbit environmental conditions.

The CIR, with the applicable PI hardware, shall meet the MPLM/on orbit environmental conditions as specified in Table IV.

3.2.6.3 On orbit condensation.

The CIR shall be designed to not cause condensation when exposed to the ISS atmosphere ranging in dewpoint from 4.4 to 15.6°C (40 to 60°F) and in relative humidity from 25 to 75%.

3.2.6.4 Special environmental conditions.

3.2.6.4.1 Load requirements.

c. The CIR shall provide positive margins of safety for launch and landing load conditions in the MPLM based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2. Loads should be consistently applied with the rack coordinate system defined in SSP 41017 Part 2, paragraph 3.1.3.
d. The CIR shall provide positive margins of safety for on orbit loads of 0.2 g acting in any direction.
e. Rack Utility Panel (RUP) umbilicals shall be restrained during launch and landing to prevent damage to loose connectors from loads and vibration.
d. CIR equipment shall provide positive margins of safety when exposed to the crew-induced loads defined in Table VI.

For design and qualification purposes, components mounted to ISPR posts shall maintain positive margins of safety for the MPLM launch random vibration environment as defined in

Table VII or

e. Table VIII.

Table IV. MPLM/on orbit environmental conditions

1.1.1.1.1.1.1.1.1 Environmental Condition	Value	
Atmospheric Conditions on ISS		
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)	
Normal operating pressure	See Figure 10	
Oxygen partial pressure	See Figure 10	
Nitrogen partial pressure	See Figure 10	
Dewpoint	4.4 to 15.6°C (40 to 60°F) ref. Figure 8	
Percent relative humidity	25 to 75% ref. Figure 11	
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-h average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg	
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-h average exposure 7.6 mm Hg Peak exposure 10 mm Hg	
Cabin air temperature in USL, JEM, APM, and CAM	17 to 28°C (63 to 82°F)	
Cabin air temperature in Node 1	17 to 31°C (63 to 87°F)	
Air velocity (Nominal)	0.051 to 0.203 m/s (10 to 40 ft/min)	
Airborne microbes	Less than 1000 CFU/m3	
Atmosphere particulate level	Average less than 100,000 particles/ft3 for particles less than 0.5 microns in size	
MPLM Air Temperatures	**Passive Flights**	**Active Flights**
Pre-Launch	15 to 24°C (59 to 75.2°F)	14 to 30°C (57.2 to 86°F)
Launch/Ascent	14 to 24°C (57.2 to 75.2°F)	20 to 30°C (68 to 86°F)
On orbit (Cargo Bay + Deployment)	24 to 44°C (75.2 to 111.2°F)	16 to 46°C (60.8 to 114.8°F)
On orbit (On-Station)	23 to 45°C (73.4 to 113°F)	16 to 43°C (60.8 to 109.4°F)
On orbit (Retrieval + Cargo Bay)	17 to 44°C (62.6 to 111.2°F)	11 to 45°C (51.8 to 113°F)
Descent/Landing	13 to 43°C (55.4 to 109.4°F)	10 to 42°C (50 to 107.6°F)
Post-Landing	13 to 43°C (55.4 to 109.4°F)	10 to 42°C (50 to 107.6°F)
Ferry Flight	15.5 to 30°C (59.9 to 86°F)	15.5 to 30°C (59.9 to 86°F)
MPLM Maximum Dewpoint Temperatures		
Pre-Launch	13.8°C (56.8°F)	12.5°C (54.5°F)
Launch/Ascent	13.8°C (56.8°F)	12.5°C (54.5°F)
On orbit (Cargo Bay + Deployment)	13.8°C (56.8°F)	12.5°C (54.5°F)
On orbit (On-Station)	15.5°C (60°F)	15.5°C (60°F)
On orbit (Retrieval + Cargo Bay)	10°C (50°F)	10°C (50°F)
Descent/Landing	10°C (50°F)	10°C (50°F)
Post-Landing	10°C (50°F)	10°C (50°F)
Ferry Flight	15.5°C (60°F)	15.5°C (60°F)
Thermal Conditions		
USL module wall temperature	13°C to 43°C (55°F to 109°F)	
JEM module wall temperature	13°C to 45°C (55°F to 113°F)	
APM module wall temperature	13°C to 43°C (55°F to 109°F) (TBR #4)	
CAM module wall temperature	13°C to 43°C (55°F to 109°F) (TBR #5)	
Other integrated payload racks	Front surface less than 37°C (98.6°F)	
*** Microgravity**		
Quasi-Steady State Environment	See Figure 12, Figure 13, and Table V	
Vibro-acoustic Environment	See Figure 14	
General Illumination	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle	
* Note: Data reflects best available information as of May, 1997. Does not include effects of CAM.		

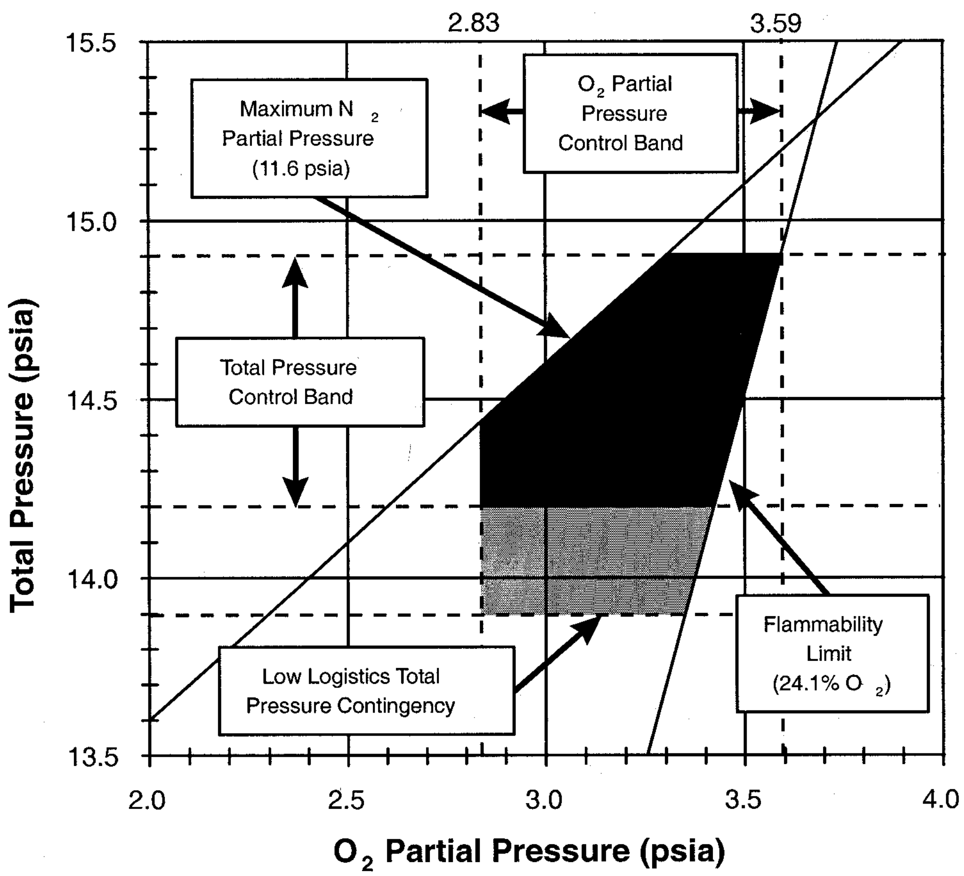


Figure 10. Operating limits of the ISS atmospheric total pressure, nitrogen, and oxygen partial pressures

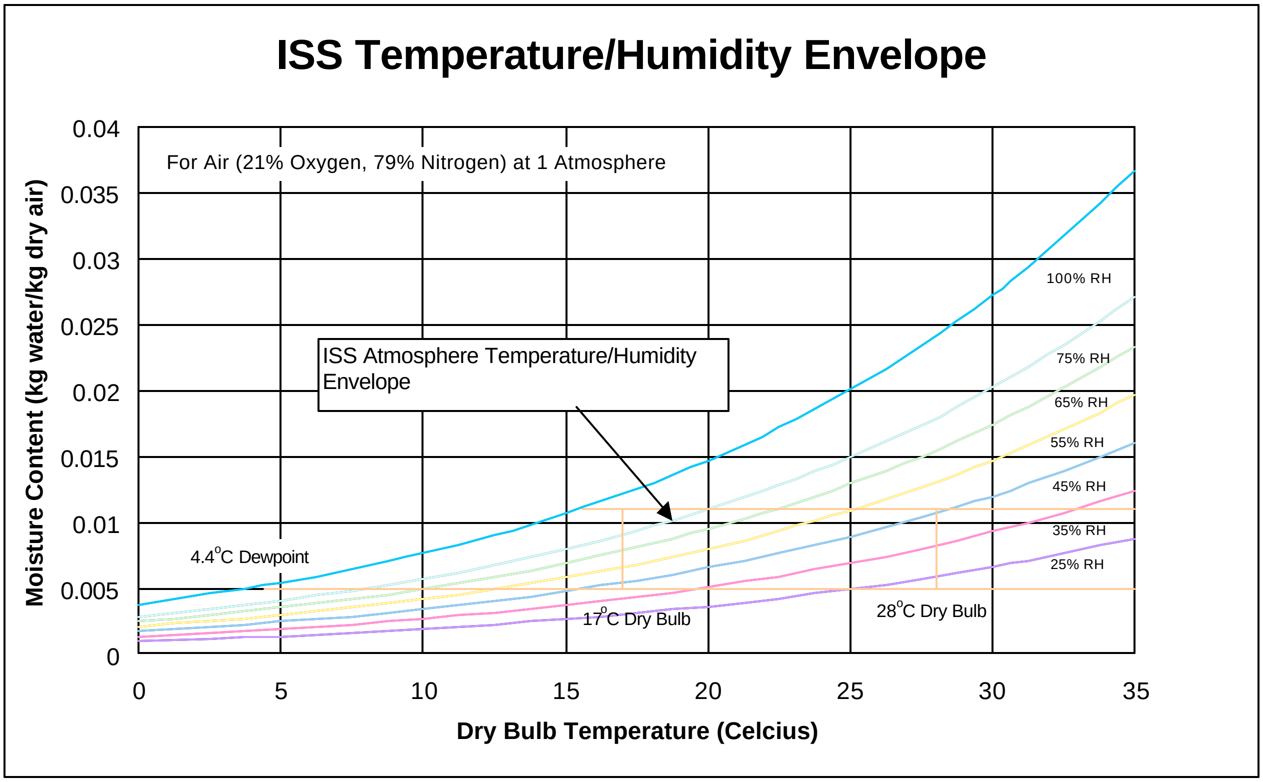


Figure 11. ISS temperature/humidity envelope

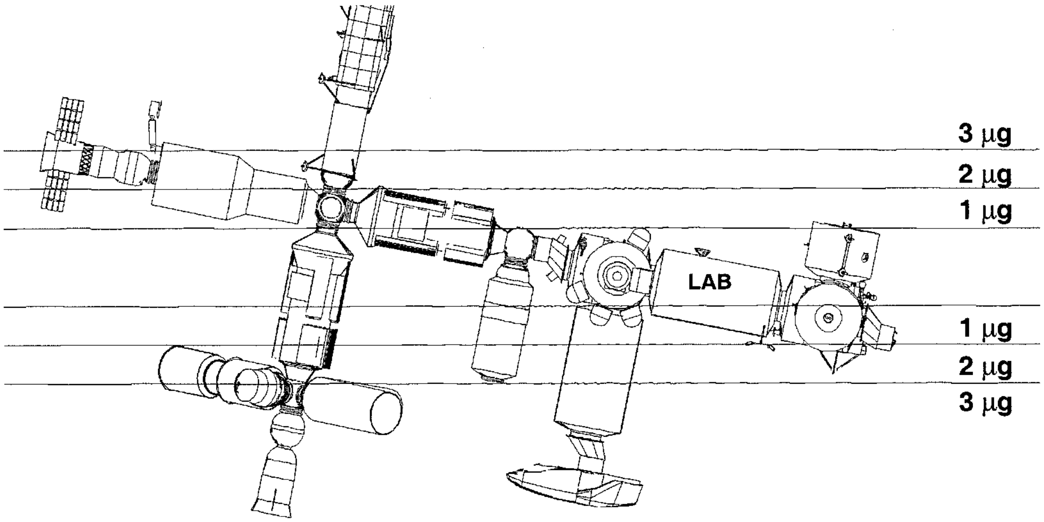


Figure 12. Assembly complete quasi-steady state microgravity contours (side)

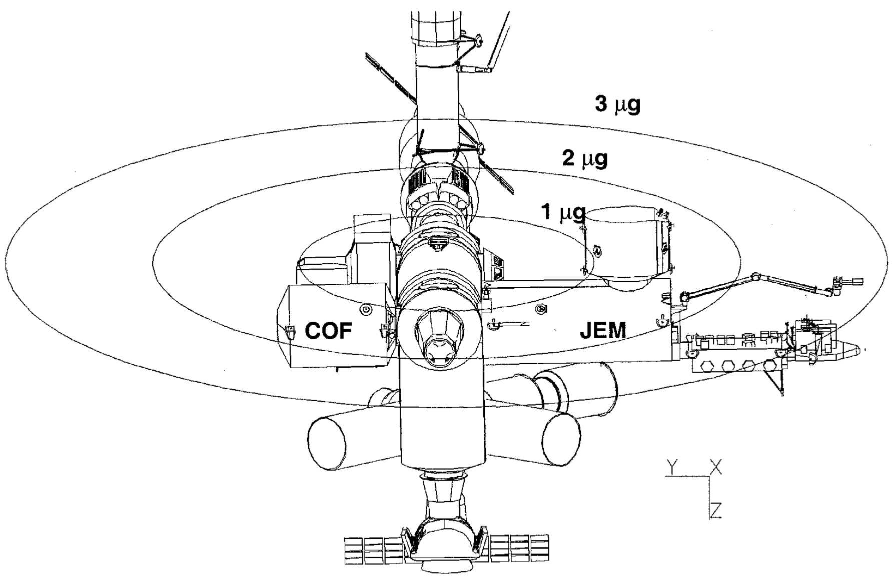
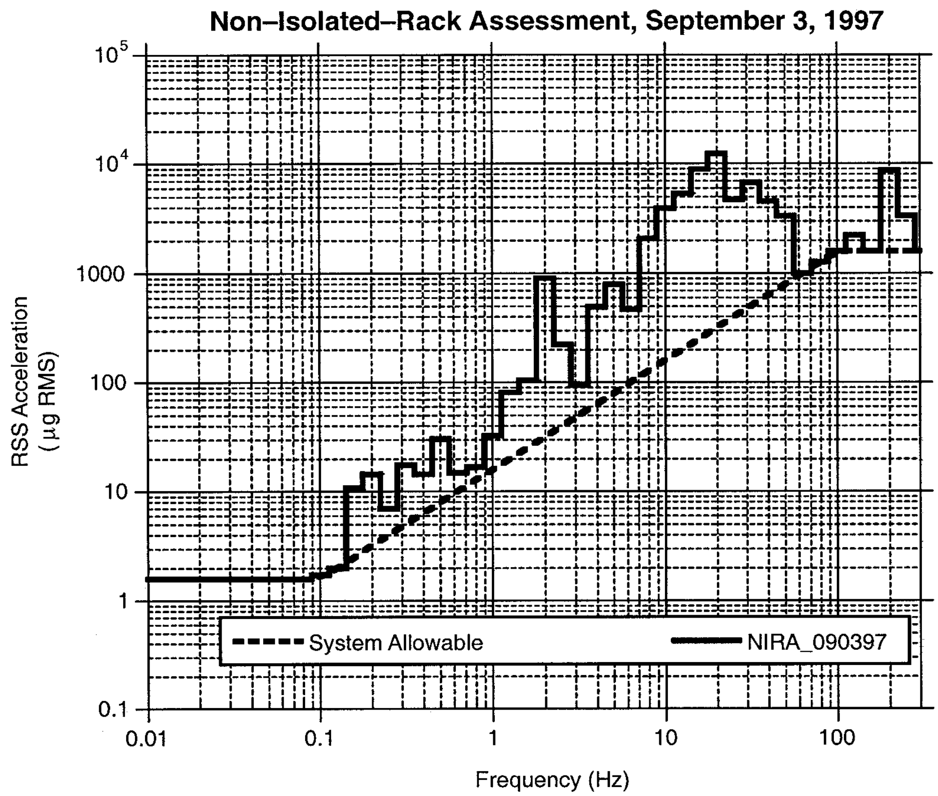


Figure 13. Assembly complete quasi-steady state microgravity contours (front)

Table V. Assembly complete quasi-steady state microgravity environment

Location (ISPRs)	Magnitude (μg)	Stability (μg)	Unit Vector Components X	Y	Z	Angle (deg)	Location (Others)	Magnitude (μg)	Stability (μg)	Unit Vector Components X	Y	Z	Angle (deg)
USL–C1	**0.525**	0.126	0.641	–0.109	0.760	17.370	USL–CG	0.793	0.137	0.466	–0.052	0.883	10.360
USL–C2	**0.468**	0.116	0.721	–0.133	0.680	20.710	APM–CG	1.624	0.157	0.288	–0.533	0.795	5.547
USL–C3	**0.419**	0.100	0.819	–0.165	0.549	24.820	APM–CLG1	1.010	0.151	0.350	–0.649	0.676	8.635
USL–C4	**0.380**	0.078	0.922	–0.204	0.330	28.370	APM–CLG2	1.120	0.154	0.313	–0.726	0.612	7.944
USL–C5	**0.356**	0.064	0.972	–0.237	–0.002	25.280	RS–FGB	1.119	0.139	–0.003	–0.060	–0.998	7.802
USL–S1	1.062	0.145	0.385	–0.227	0.895	7.927	RS–SM	2.179	0.129	–0.099	–0.038	–0.994	3.655
USL–S2	**0.989**	0.143	0.400	–0.248	0.883	8.421	JEM–CG	1.811	0.157	0.244	0.745	0.621	5.143
USL–S3	**0.917**	0.141	0.417	–0.272	0.867	8.973	JEF1–F1	2.954	0.165	0.223	0.627	0.746	3.325
USL–S4	**0.846**	0.138	0.437	–0.300	0.848	9.859	JEF2–A1	2.613	0.160	0.218	0.706	0.674	3.646
USL–P1	1.019	0.145	0.396	0.166	0.903	8.310	JEF3–F2	3.039	0.167	0.216	0.658	0.722	3.265
USL–P2	**0.945**	0.143	0.413	0.180	0.893	8.866	JEF4–A2	2.710	0.162	0.209	0.734	0.646	3.558
USL–P4	**0.799**	0.138	0.458	0.215	0.862	10.230	JEF5–F3	3.129	0.169	0.209	0.685	0.698	3.208
JPM1–A1	1.250	0.150	0.348	0.333	0.877	7.015	JEF6–A3	2.811	0.164	0.201	0.760	0.619	3.477
JPM2–F1	1.480	0.154	0.325	0.282	0.903	6.095	JEF7–F4	3.223	0.171	0.203	0.710	0.674	3.155
JPM3–A2	1.296	0.151	0.334	0.433	0.838	6.819	JEF8–A4	2.915	0.167	0.194	0.782	0.593	3.401
JPM4–F2	1.519	0.154	0.316	0.370	0.874	5.979	JEF9–O1	3.303	0.174	0.188	0.771	0.608	3.135
JPM5–A3	1.355	0.151	0.318	0.520	0.793	6.570	JEF10–O2	3.091	0.174	0.174	0.838	0.517	3.334
JPM6–F3	1.569	0.155	0.305	0.450	0.839	5.824	JEF11–U1	2.456	0.169	0.184	0.861	0.474	4.064
JPM7–A4	1.425	0.152	0.301	0.594	0.746	6.288	JEF12–U2	2.553	0.171	0.170	0.890	0.423	3.955
JPM8–A5	1.505	0.153	0.284	0.657	0.699	5.992	S3LO	3.299	0.223	0.038	–0.994	–0.104	3.918
JPM9–F5	1.700	0.156	0.280	0.584	0.762	5.441	S3LI	2.945	0.212	0.042	–0.991	–0.124	4.180
JPM10–F6	1.778	0.157	0.266	0.638	0.723	5.234	S3UO	3.958	0.209	–0.056	–0.846	–0.530	3.142
APM–FWD1	1.605	0.155	0.305	–0.386	0.871	5.573	S3UI	3.644	0.196	–0.062	–0.810	–0.584	3.222
APM–FWD2	1.681	0.157	0.291	–0.465	0.836	5.370	P3LO	3.260	0.191	0.022	0.973	–0.231	3.355
APM–FWD3	1.768	0.159	0.277	–0.532	0.800	5.167	P3UO	4.043	0.176	–0.068	0.780	–0.622	2.494
APM–FWD4	1.863	0.161	0.263	–0.590	0.763	4.968							
APM–AFT1	1.397	0.152	0.318	–0.451	0.834	6.275							
APM–AFT2	1.482	0.154	0.300	–0.534	0.791	5.989							
APM–AFT3	1.578	0.157	0.282	–0.603	0.747	5.709							
APM–AFT4	1.682	0.160	0.264	–0.659	0.704	5.450							

10 ISPRs Have Quasi–Steady Magnitude </= 1.0 g



Note: The Non-Isolated Rack Assessment (NIRA) is a prediction of the "vehicle induced", Assembly Complete, acceleration environment at non-isolated ISPRs during microgravity mode. The acceleration environment depicted represents a 100 second, root-mean-square average per one-third octave band from 0.01 to 300 Hz at the rack to module structural interfaces. It is intended to represent the enveloped acceleration response over all the non-isolated ISPR locations in the U.S. Lab, JEM, and APM. The NIRA is based on the DAC–4 ISS assessment of vehicle microgravity compliance which computed the acceleration response to all significant U.S. and Russian segment disturbance sources. To account for the ESA and NASDA disturbance sources, the NIRA at this time assumes that the acceleration responses produced by the ESA and NASDA disturbances are equivalent to the responses produced by the U.S. Lab, Hab, and Airlock disturbances combined less exercise equipment. A similar assumption is also used to account for the CAM in this NIRA. Thus, with these assumptions, the NIRA accounts for all "vehicle induced" accelerations during microgravity mode. The NIRA does not account for "payload induced" accelerations nor "crew induced" accelerations, other than those produced by the crew when using exercise devices. The NIRA is expected to be updated as improved predictions become available.

Figure 14. Assembly complete vibratory environment

f. Components mounted to the ISPR's shall maintain positive margins of safety for the launch and landing conditions in the MPLM. For early design, the acceleration environment defined in Table IX will be used. These load factors will be superseded by load factors obtained though an ISS-performed coupled loads analysis as described in SSP 52005.

Table VI. Crew-induced loads

CREW SYSTEM OR STRUCTURE	TYPE OF LOAD	LOAD	DIRECTION OF LOAD
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N–m (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf)	Any direction
Rack front panels and any other normally exposed equipment	Load distributed over a 4 inch by 4 inch area	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

Table VII. Random vibration criteria for ISPR post-mounted equipment weighing 100 pounds or less in the MPLM

FREQUENCY	LEVEL
20 Hz	0.005 g^2/Hz
20–70 Hz	+ 5.0 dB/oct
70–200 Hz	0.04 g^2/Hz
200–2000 Hz	–3.9 dB/oct
2000 Hz	0.002 g^2/Hz
Composite	4.4 grms
Note: Criteria is the same for all directions (X,Y,Z)	

Table VIII. Random vibration criteria for ISPR post-mounted equipment weighing more than 100 pounds in the MPLM

FREQUENCY	LEVEL
20 Hz	0.002 g2/Hz
20–70 Hz	+ 4.8 dB/oct
70–200 Hz	0.015 g2/Hz
200–2000 Hz	–3.7 dB/oct
2000 Hz	0.0006 g2/Hz
Composite	2.4 grms
Note: Criteria is the same for all directions (X,Y,Z)	

Table IX. Payload ISPR mounted equipment load factors (equipment frequency 35 Hz)

Liftoff	X	Y	Z
(g)	± 7.7	± 11.6	± 9.9
Landing	**X**	**Y**	**Z**
(g)	± 5.4	± 7.7	± 8.8
Note: Load factors apply concurrently in all possible combinations for each event and are shown in the rack coordinate system defined in SSP 41017, Part 2, paragraph 3.1.3.			

3.2.6.4.2 Rack requirements.

a. The CIR shall maintain positive margins of safety for the on orbit depress/repress rates identified in SSP 41002, paragraph 3.1.7.2.1.
b. The CIR and kneebrace shall have a modal frequency in accordance with SSP 52005, paragraph 5.7, second paragraph for launch and landing, based on rigidly mounting the integrated rack in the launch configuration.
c. Equipment mounted directly to the CIR ISPR will have a modal frequency goal of 35 Hz for launch and landing, based on rigidly mounting the component at the component to rack interface.
d. The CIR shall comply with the keep-out zone for rack pivot mechanism as defined in SSP 41017 Part 1, paragraph 3.2.1.1.2.
e. The CIR shall be capable of rotating a minimum of 80 degrees about the pivot point for on orbit installation, removal, and ISS maintenance functions.
f. The CIR and CIR equipment that have Portable Fire Extinguisher (PFE) access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 15.

g. The CIR shall use the rack and crew restraints identified in SSP 30257:004 (for example, the 14-in. fixed-length tether and the 71-in. adjustable-length tether) to secure the rack in these rotated positions for payload operations and maintenance.
h. The CIR shall not have a pressure relief device on the front of the rack.
i. The CIR shall be designed in accordance with the requirements specified in SSP 52005.
j. For frequencies below 0.01 Hz, the CIR shall limit unbalanced translational average impulse to generate less than 10 lb-s (44.8 N-s) within any 10 to 500 second period, along any ISS coordinate system vector.
k. Between 0.01 and 300 Hz, the inactive ARIS CIR shall limit vibration so that the limits of Figure 16 are not exceeded using the force method, or the limits of Table 3.1.2.2-2 are not exceeded using the acceleration method.
l. The CIR shall limit force applied to the ISS over any ten second period to an impulse of no greater than 10 lb-s (44.5 N-s). Non-rack payloads shall limit force applied to the ISS over any ten second period to an impulse of no greater than 2.5 lb-s (11.1 N-s).
m. The CIR shall limit their peak force applied to the ISS to less than 1000 lb (4448 N) for any duration. NOTE: Meeting the transient requirements of both l and m does not obviate the need to also meet the 100 second vibration requirement of k for vibration included in and following the transient disturbance.
n. CIR vibration induced by payloads shall not exceed the on-board to off-board vibration force limit of Figure 3.1.2.5-1 during microgravity periods, considering ARIS suspended rack structural dynamics and control system interaction, while ARIS is actively isolating.

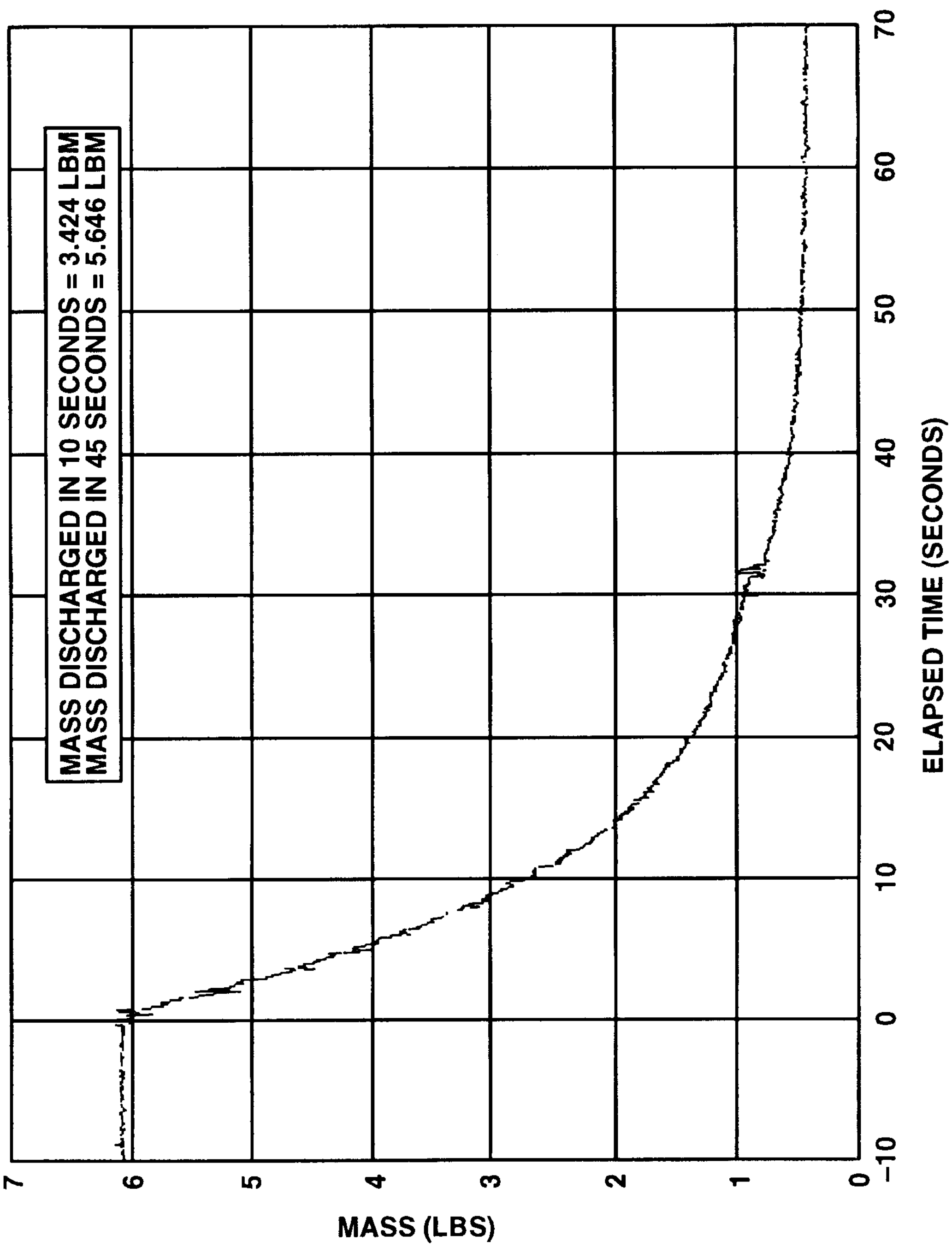


Figure 15. Manual fire suppression system performance characteristics at the rack interface

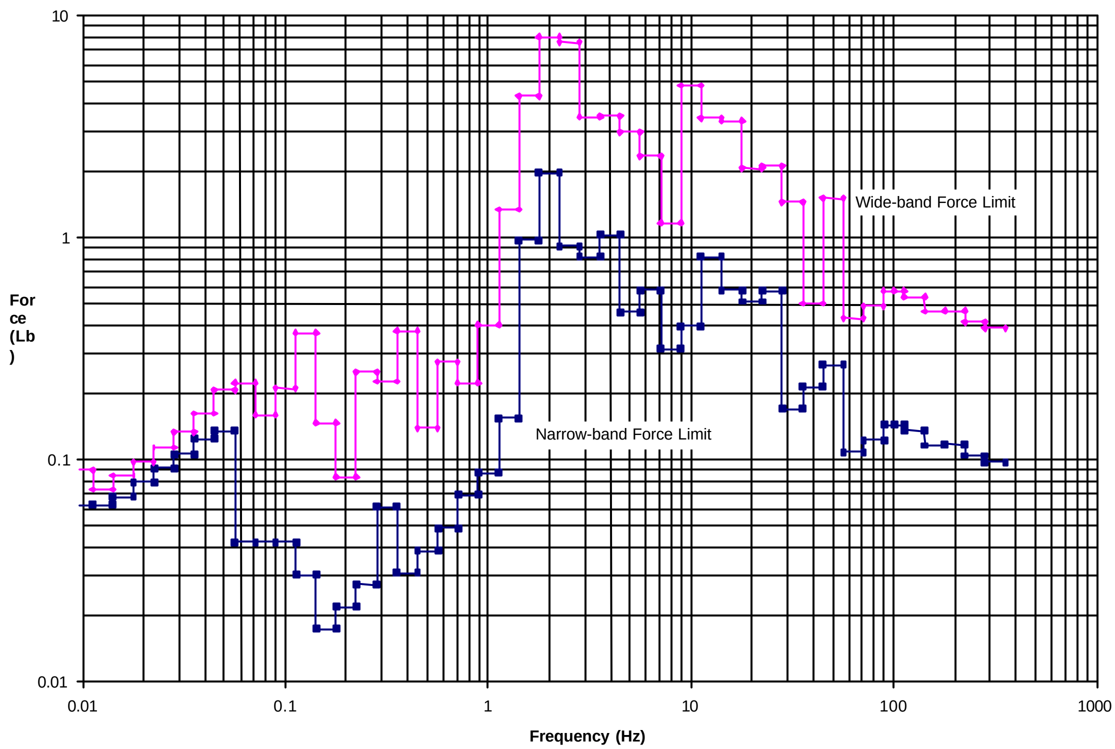


Figure 16. Allowable one-third octave interface forces for integrated racks and non-payloads, 0.5% damping factor

Table X. Allowable integrated rack narrow-band envelope and wideband inteface force values for ISPRs, 0.5% damping factor

Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f
0.008913	0.06261	0.089635	0.3548	0.061482	0.224779	11.22	0.817148	3.451307
0.01122	0.06261	0.089635	0.3548	0.030924	0.378806	14.13	0.817148	3.451307
0.01122	0.06261	0.073218	0.4467	0.030924	0.378806	14.13	0.579786	3.358266
0.01413	0.06261	0.073218	0.4467	0.038934	0.138909	17.78	0.579786	3.358266
0.01413	0.068172	0.084667	0.5623	0.038934	0.138909	17.78	0.516921	2.048448
0.01778	0.068172	0.084667	0.5623	0.04901	0.274588	22.39	0.516921	2.048448
0.01778	0.079202	0.097495	0.7079	0.04901	0.274588	22.39	0.57451	2.091627
0.02239	0.079202	0.097495	0.7079	0.06922	0.222568	28.18	0.57451	2.091627
0.02239	0.091377	0.112968	0.8913	0.06922	0.222568	28.18	0.168996	1.443748
0.02818	0.091377	0.112968	0.8913	0.087153	0.404688	35.48	0.168996	1.443748
0.02818	0.105641	0.133067	1.122	0.087153	0.404688	35.48	0.212776	0.50643
0.03548	0.105641	0.133067	1.122	0.154561	1.337042	44.67	0.212776	0.50643
0.03548	0.123739	0.161094	1.413	0.154561	1.337042	44.67	0.267886	1.498072
0.04467	0.123739	0.161094	1.413	0.976353	4.322593	56.23	0.267886	1.498072
0.04467	0.134457	0.205508	1.778	0.976353	4.322593	56.231	0.10793	0.431721
0.05623	0.134457	0.205508	1.778	1.953413	8.01995	70.79	0.10793	0.431721
0.05623	0.042699	0.22137	2.239	1.953413	8.01995	70.791	0.122491	0.489965
0.07079	0.042699	0.22137	2.239	0.915835	7.567684	89.13	0.122491	0.489965
0.07079	0.042699	0.158917	2.818	0.915835	7.567684	89.131	0.143827	0.575309
0.08913	0.042699	0.158917	2.818	0.818034	3.504552	100	0.143827	0.575309
0.08913	0.042699	0.2093	3.548	0.818034	3.504552	112.2	0.143827	0.575309
0.1122	0.042699	0.2093	3.548	1.029953	3.531682	112.2	0.135367	0.541469
0.1122	0.030213	0.373089	4.467	1.029953	3.531682	141.3	0.135367	0.541469
0.1413	0.030213	0.373089	4.467	0.460611	2.979207	141.3	0.115819	0.463274
0.1413	0.017289	0.146008	5.623	0.460611	2.979207	177.8	0.115819	0.463274
0.1778	0.017289	0.146008	5.623	0.579824	2.330438	177.8	0.116941	0.467763
0.1778	0.021755	0.083429	7.079	0.579824	2.330438	223.9	0.116941	0.467763
0.2239	0.021755	0.083429	7.079	0.315606	1.16448	223.9	0.104363	0.417452
0.2239	0.027396	0.24715	8.913	0.315606	1.16448	281.8	0.104363	0.417452
0.2818	0.027396	0.24715	8.913	0.39737	4.848007	281.8	0.097688	0.390751
0.2818	0.061482	0.224779	11.22	0.39737	4.848007	354.8	0.097688	0.390751

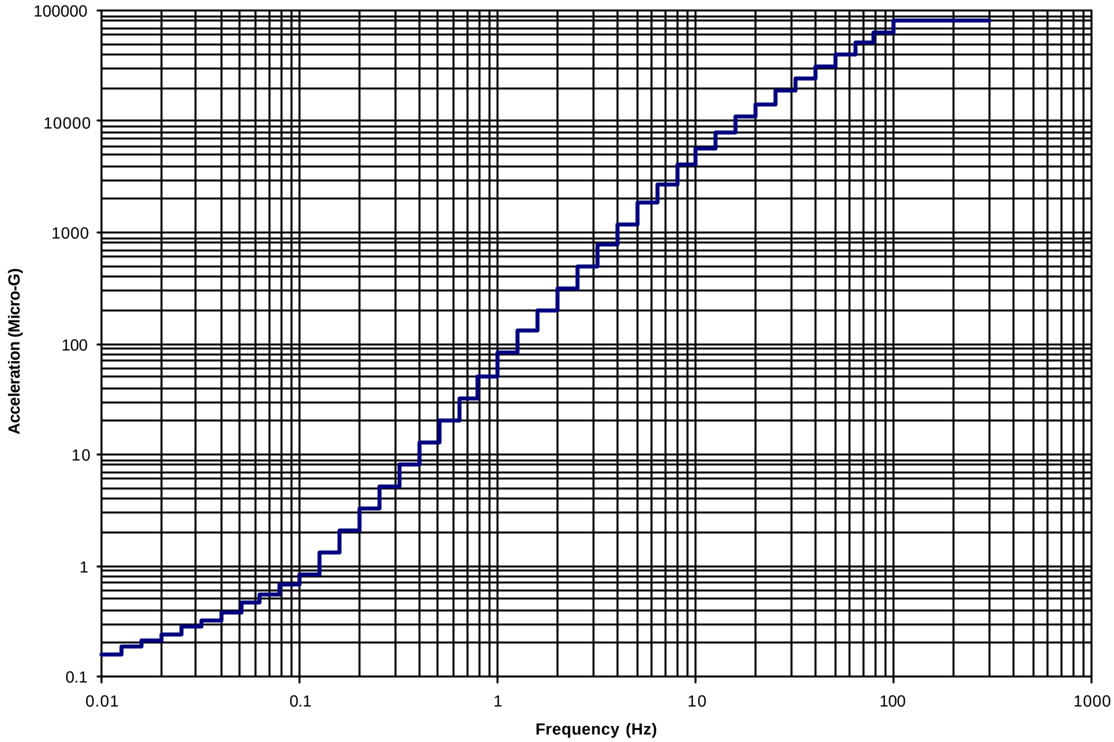


Figure 17. Non-ARIS-to ARIS acceleration limit alternative to force limits

Table XI. Non-ARIS integrated rack to ARIS acceleration limit alternative to force limits

Freq	Accel Limit (ug)	Freq	Accel Limit (ug)	Freq	Accel Limit (ug)
0.0089	0.159	0.226	5.18	5.74	2746
0.0112	0.159	0.285	5.18	7.23	2746
0.0112	0.185	0.285	8.19	7.23	4026
0.0141	0.185	0.359	8.19	9.11	4026
0.0141	0.213	0.359	12.97	9.11	5758
0.0178	0.213	0.452	12.97	11.48	5758
0.0178	0.244	0.452	20.53	11.48	8021
0.0224	0.244	0.570	20.53	14.47	8021
0.0224	0.281	0.570	32.49	14.47	10898
0.0283	0.281	0.718	32.49	18.23	10898
0.0283	0.325	0.718	51.42	18.23	14495
0.0356	0.325	0.904	51.42	22.96	14495
0.0356	0.383	0.904	81.33	22.96	18956
0.0449	0.383	1.139	81.33	28.93	18956
0.0449	0.458	1.139	128.51	28.93	24483
0.0565	0.458	1.435	128.51	36.45	24483
0.0565	0.556	1.435	202.73	36.45	31346
0.0712	0.556	1.808	202.73	45.93	31346
0.0712	0.682	1.808	318.99	45.93	39894
0.0897	0.682	2.278	318.99	57.87	39894
0.0897	0.843	2.278	499.90	57.87	50578
0.1130	0.843	2.871	499.90	72.91	50578
0.1130	1.322	2.871	778.69	72.91	63958
0.1424	1.322	3.617	778.69	91.86	63958
0.1424	2.079	3.617	1202.18	91.86	80751
0.1794	2.079	4.557	1202.18	100.00	80751
0.1794	3.280	4.557	1832.55	300.00	80751
0.2260	3.280	5.741	1832.55		

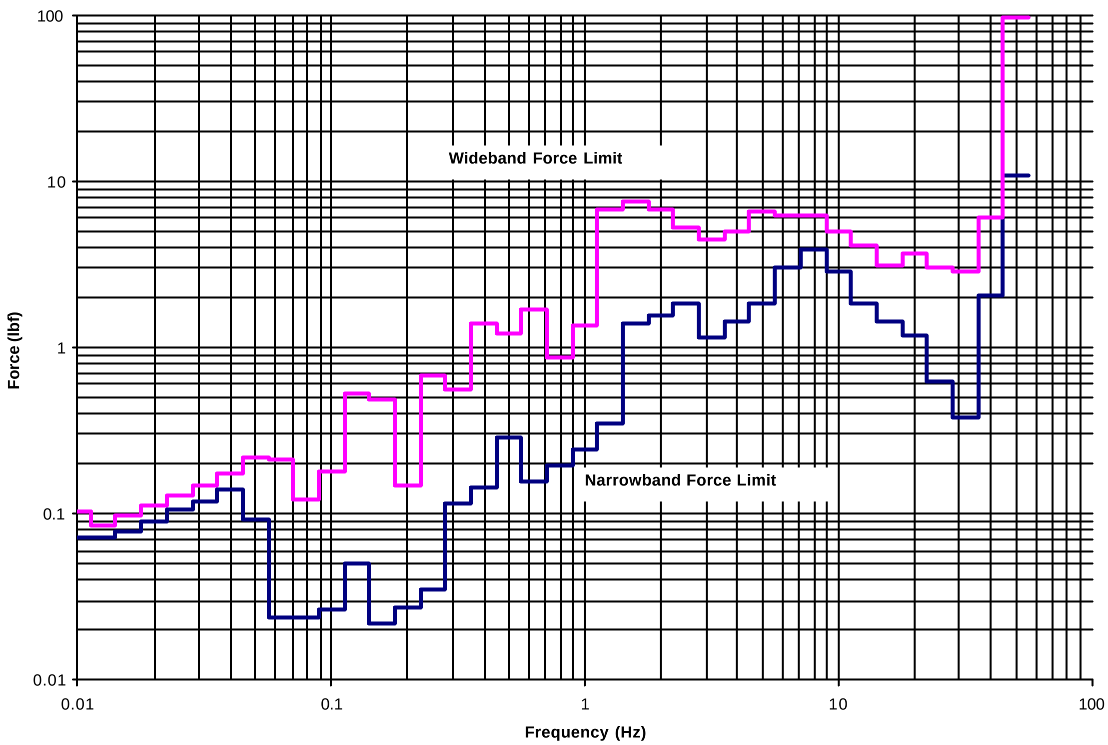


Figure 18. Allowable on-board force values for ARIS integrated payloads to meet off-board limits

Table XII. Allowable on-board force values for ARIS integrated payloads to meet off-board limits

Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)	Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)	Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)
0.0089	0.0722	0.1033	0.1778	0.0274	0.1466	3.5480	1.4337	5.0388
0.0112	0.0722	0.1033	0.2239	0.0274	0.1466	4.4670	1.4337	5.0388
0.0112	0.0722	0.0842	0.2239	0.0346	0.6819	4.4670	1.8234	6.6213
0.0141	0.0722	0.0842	0.2818	0.0346	0.6819	5.6230	1.8234	6.6213
0.0141	0.0785	0.0971	0.2818	0.1147	0.5577	5.6230	3.0271	6.2002
0.0178	0.0785	0.0971	0.3548	0.1147	0.5577	7.0790	3.0271	6.2002
0.0178	0.0910	0.1113	0.3548	0.1445	1.3967	7.0790	3.8832	6.2891
0.0224	0.0910	0.1113	0.4467	0.1445	1.3967	8.9130	3.8832	6.2891
0.0224	0.1046	0.1279	0.4467	0.2881	1.2088	8.9130	2.9020	5.0388
0.0282	0.1046	0.1279	0.5623	0.2881	1.2088	11.2200	2.9020	5.0388
0.0282	0.1201	0.1488	0.5623	0.1554	1.7174	11.2200	1.8602	4.0770
0.0355	0.1201	0.1488	0.7079	0.1554	1.7174	14.1300	1.8602	4.0770
0.0355	0.1392	0.1763	0.7079	0.1945	0.8709	14.1300	1.4350	3.0919
0.0447	0.1392	0.1763	0.8913	0.1945	0.8709	17.7800	1.4350	3.0919
0.0447	0.0926	0.2167	0.8913	0.2416	1.3743	17.7800	1.1754	3.7060
0.0562	0.0926	0.2167	1.1220	0.2416	1.3743	22.3900	1.1754	3.7060
0.0562	0.0240	0.2147	1.1220	0.3449	6.7131	22.3900	0.6179	3.0764
0.0708	0.0240	0.2147	1.4130	0.3449	6.7131	28.1800	0.6179	3.0764
0.0708	0.0240	0.1225	1.4130	1.3847	7.6318	28.1800	0.3821	2.9013
0.0891	0.0240	0.1225	1.7780	1.3847	7.6318	35.4800	0.3821	2.9013
0.0891	0.0269	0.1820	1.7780	1.5667	6.7883	35.4800	2.0342	6.0143
0.1122	0.0269	0.1820	2.2390	1.5667	6.7883	44.6700	2.0342	6.0143
0.1122	0.0502	0.5226	2.2390	1.8464	5.2891	44.6700	10.9057	96.2593
0.1413	0.0502	0.5226	2.8180	1.8464	5.2891	56.2300	10.9057	96.2593
0.1413	0.0218	0.4830	2.8180	1.1511	4.4228			
0.1778	0.0218	0.4830	3.5480	1.1511	4.4228			

3.2.6.4.3 Electrical requirements.

3.2.6.4.3.1 Steady-state voltage characteristics.

The CIR at Interface B shall operate and be compatible with the steady-state voltage limits of 116 to 126 Vdc.

3.2.6.4.3.2 Ripple voltage characteristics.

a. The CIR Electrical Power Consuming Equipment (EPCE) connected to Interface B shall operate and be compatible with the Electrical Power System (EPS) time domain ripple voltage and noise level of at least 2.5 Vrms within the frequency range of 30 Hz to 10 kHz.
b. The CIR EPCE connected to Interface B shall operate and be compatible with the EPS Ripple Voltage Spectrum as shown in Figure 19.
Note: This limit is 6 dB below the electromagnetic compatibility (EMC) CS-01, CS–02 requirement in SSP 30237 up to 30 MHz.

3.2.6.4.3.3 Transient voltages.

The CIR at Interface B shall operate and be compatible with the limits of magnitude and duration for the voltage transients at Interface B as shown in Figure 20.

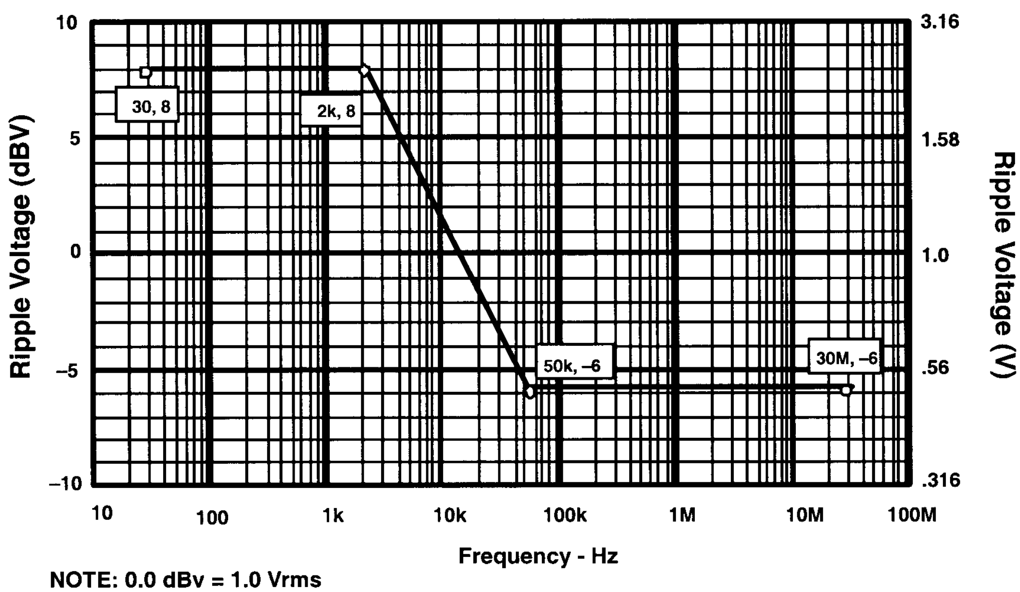


Figure 19. Maximum Interfaces B and C ripple voltage spectrum

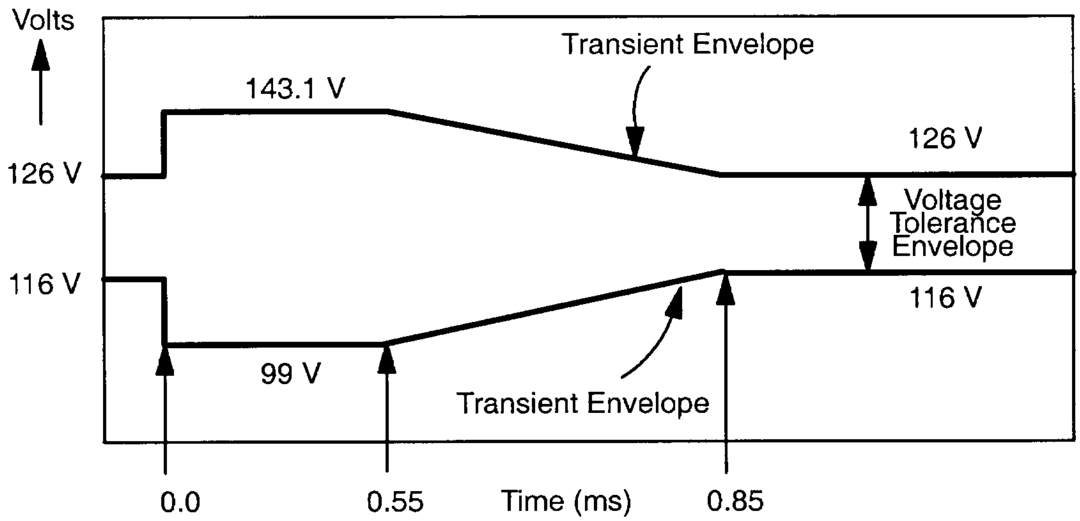


Figure 20. Interface B voltage transients

The envelope shown in this figure applies to the transient responses exclusive of any periodic ripple or noise components that may be present.

3.2.6.4.3.4 Fault clearing and protection.

The CIR EPCE connected to Interface B shall be safe and not suffer damage with the transient voltage conditions that are within the limits shown in Figure 21. Loads may be exposed to transient overvoltage conditions during operation of the power system's fault protection components.

3.2.6.4.3.5 Non-normal voltage range.

The CIR EPCE connected to Interface B shall not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware with non-normal voltage characteristics of a maximum overvoltage of + 165 Vdc for 10 s and undervoltage conditions of +102 Vdc for an indefinite period of time.

3.2.6.4.3.6 Power bus isolation.

a. The CIR shall provide a minimum of 1-MΩ isolation in parallel with not more than 0.03 μF of mutual capacitance within internal and external rack EPCE at all times such that no single failure shall cause the independent power buses to be electrically tied. (Mutual capacitance is defined as line-to-line capacitance, exclusive of the EMI input filter.)
b. CIR internal and external CIR shall not use diodes to electrically tie together independent ISS power bus high side or return lines. These requirements apply to both supply and return lines. ISS provides the capability to support simultaneous use of Main (J1) and Auxiliary (J2) power at each ISPR location (except MPLM). Constrained element level payload operations

may occur from individual payload racks which automatically switch to or require simultaneous use of auxiliary power.

3.2.6.4.3.7 Compatibility with soft start/stop remote power controller (RPC).

The CIR EPCE connected to the Interface B shall initialize with the soft start/stop performance characteristics when power is applied, sustained, and removed by control of remote power control switches as specified in Figure 22.

3.2.6.4.3.8 Surge current.

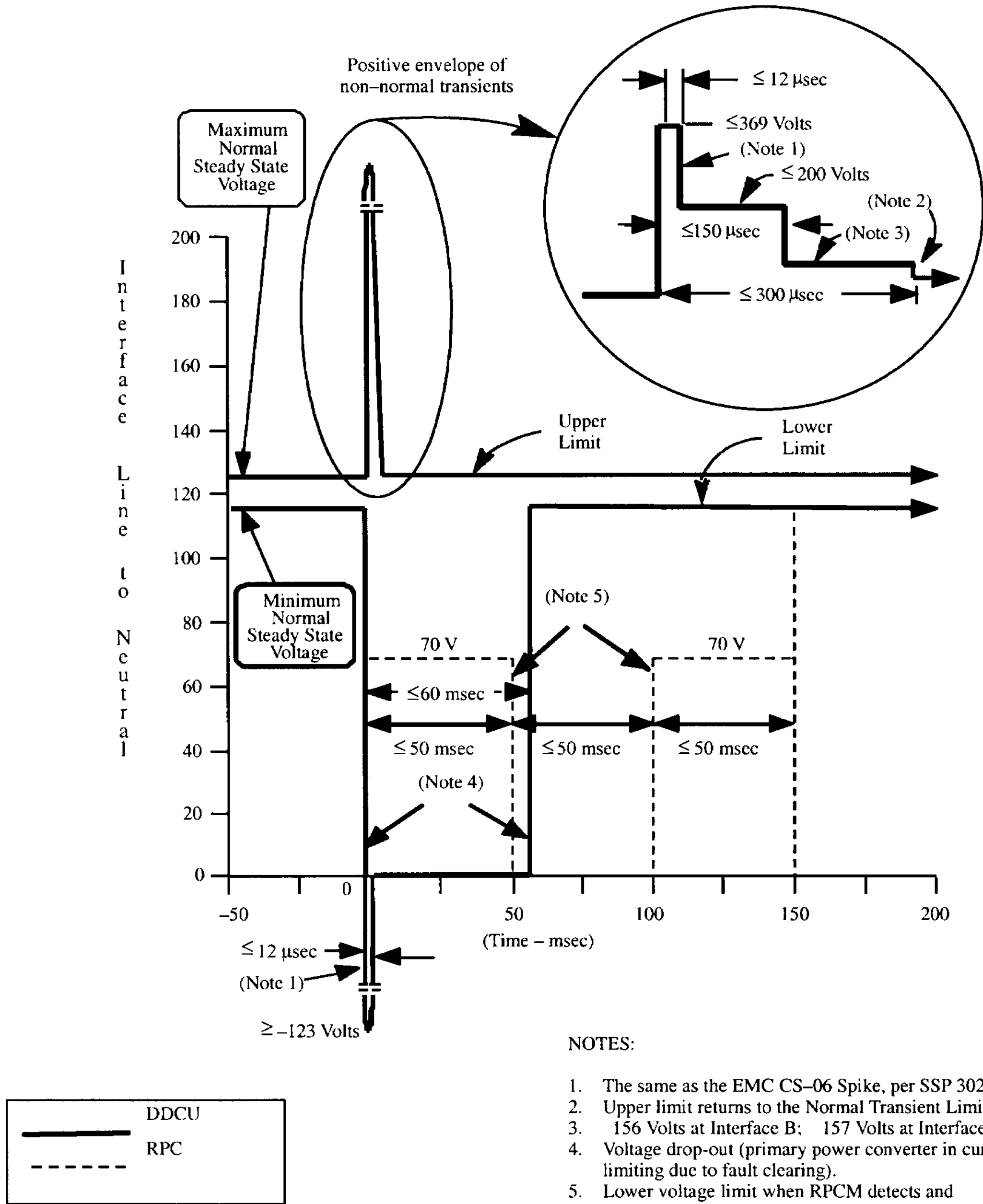
The CIR EPCE connected to Interface B electrical interface surge current at the power inputs shall not exceed the surge current values defined in Figure 23 and Figure 24 when powered from a voltage source with characteristics specified in SSP 57000, paragraphs 3.2.1 and 3.2.2.3, with the exception that the source impedance is considered to be 0.1 Ω. The duration of the surge current shall not exceed 10 ms. These requirements apply to all operating modes and changes including power-up and power-down.

3.2.6.4.3.9 Reverse energy/current.

The CIR electrical interface main input power and Auxiliary input power shall comply with the requirements defined in Table XIII for the reverse energy/current into the upstream power source. The CIR interface shall meet either the reverse energy or the reverse current requirement for all environmental conditions specified in this document when powered from a voltage source with characteristics specified in SSP 57000, paragraphs 3.2.1 and 3.2.2.3 with a source impedance of 0.1 Ω.

3.2.6.4.3.10 Current protection devices.

a. The CIR shall operate and be compatible with the characteristics in Figures 3.2.6–2, 3.2.6–3, and 3.2.6–4 as described in paragraph 3.2.6 located in SSP 57001.
b. Overcurrent protection shall be provided at all points in the system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines.
c. The CIR shall provide current limiting overcurrent protection for all internal loads (exclusive of overcurrent protection circuits and devices) drawing power from an Interface B power feed. For the purpose of this requirement, internal overcurrent protection circuits and devices are not considered to be loads.



NOTES:

1. The same as the EMC CS–06 Spike, per SSP 30237.
2. Upper limit returns to the Normal Transient Limit.
3. 156 Volts at Interface B; 157 Volts at Interface C.
4. Voltage drop-out (primary power converter in current limiting due to fault clearing).
5. Lower voltage limit when RPCM detects and responds to under voltage conditions.

Figure 21. Fault clearing and protection transient limits

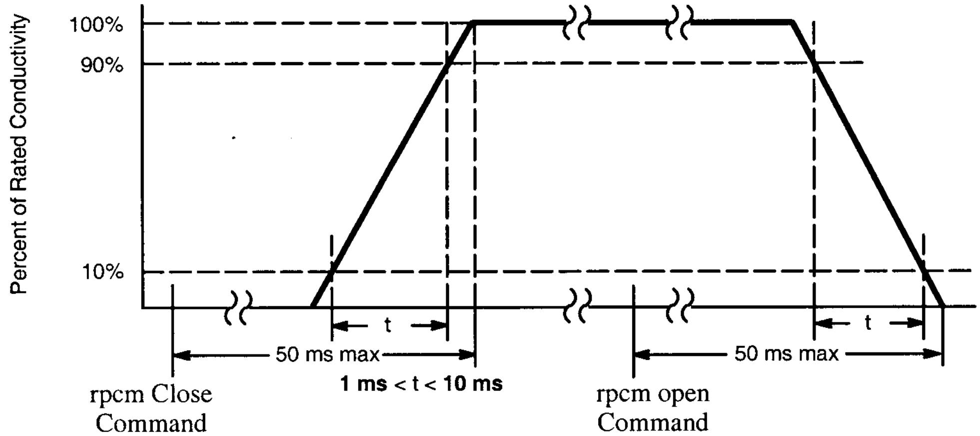


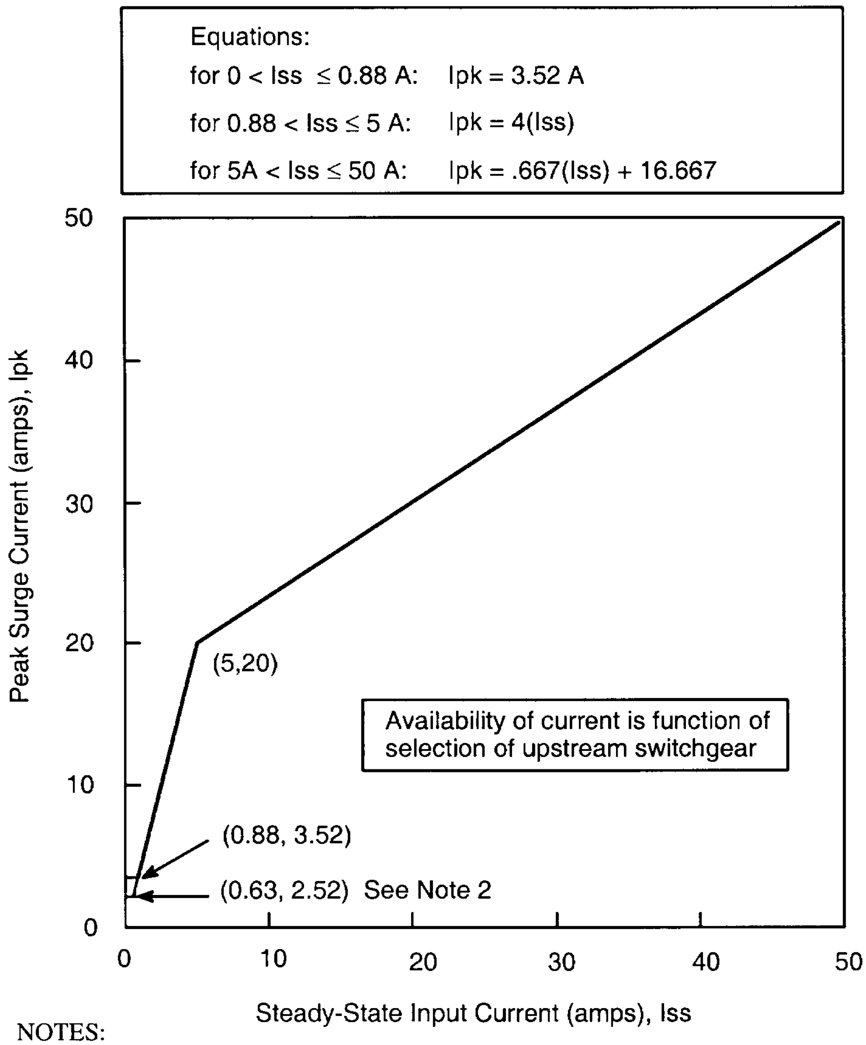
Figure 22. U.S. RPCM soft start/stop characteristics

3.2.6.4.3.11 CIR trip rating.

The payload power circuit protection device in the CIR connected to Interface B shall be designed to provide trip coordination, (i.e., the downstream circuit protection device disconnects a shorted circuit or an overloaded circuit from the upstream power interface without tripping the upstream circuit protection device). The trip coordination is achieved either by shorter trip time or lower current limitation than the upstream protection devices defined in paragraph 3.2.6.4.3.10 a.

3.2.6.4.3.12 Interface B complex load impedances.

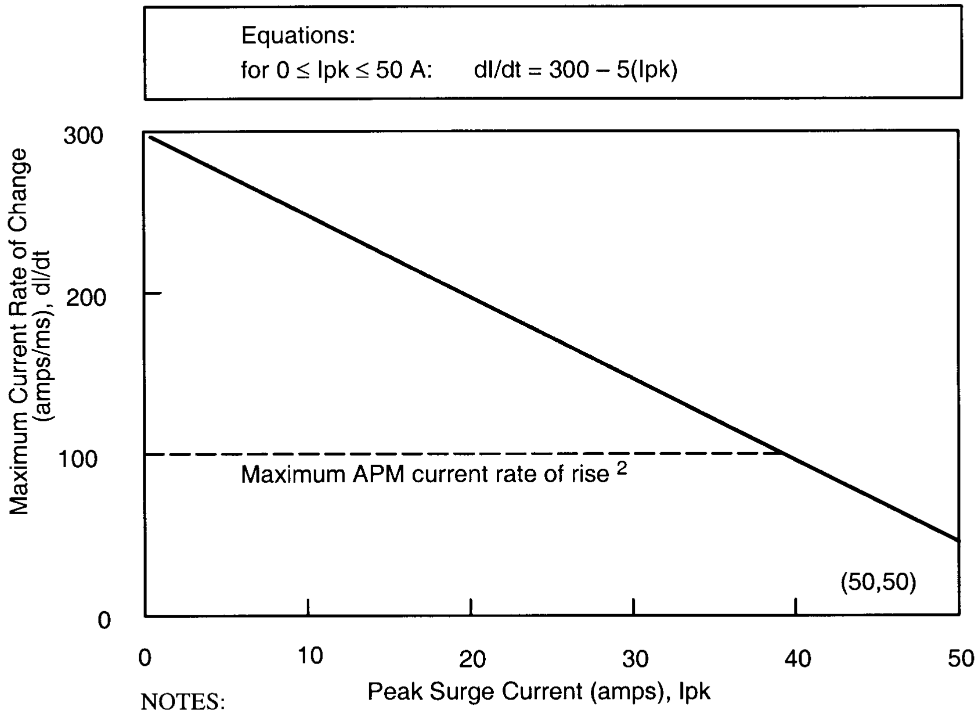
a. The load impedance presented by the CIR to the Main Interface B shall not exceed the bounds defined by Figure 25 and Figure 26 for input over the frequency range of 50 Hz to 100 kHz. The magnitude component of the CIR input impedance should not be less than the minimum defined in Figure 25 and Figure 26. At frequencies where the magnitude component of the CIR input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in Figure 25 and Figure 26.
b. The load impedance presented by the CIR to the 1.2 to 1.44 kW Interface B shall not exceed the bounds defined by Figure 27 for input over the frequency range of 50 Hz to 100 kHz. The magnitude component of the CIR input impedance should not be less than the minimum defined in Figure 27. At frequencies where the magnitude component of the CIR input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in Figure 27.



NOTES:

1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station equipment accommodated in JEM will have a maximum allowable peak surge current of 2.52 amps for equipment having a steady-state input no greater than 0.63 amps.

Figure 23. Peak surge current amplitude versus steady-state input current



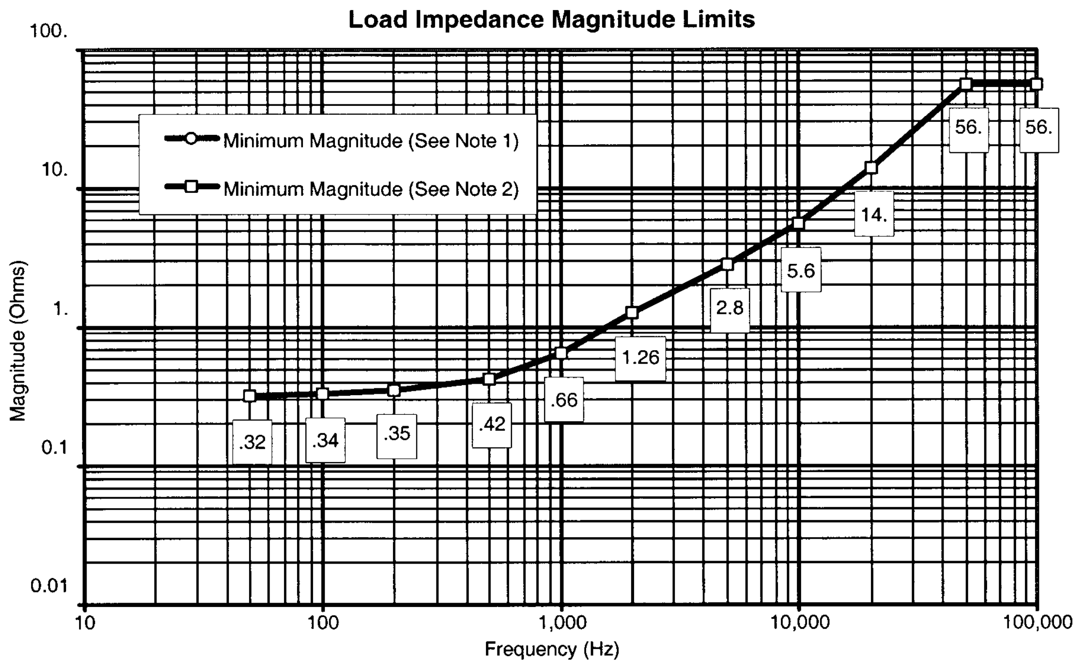
NOTES:

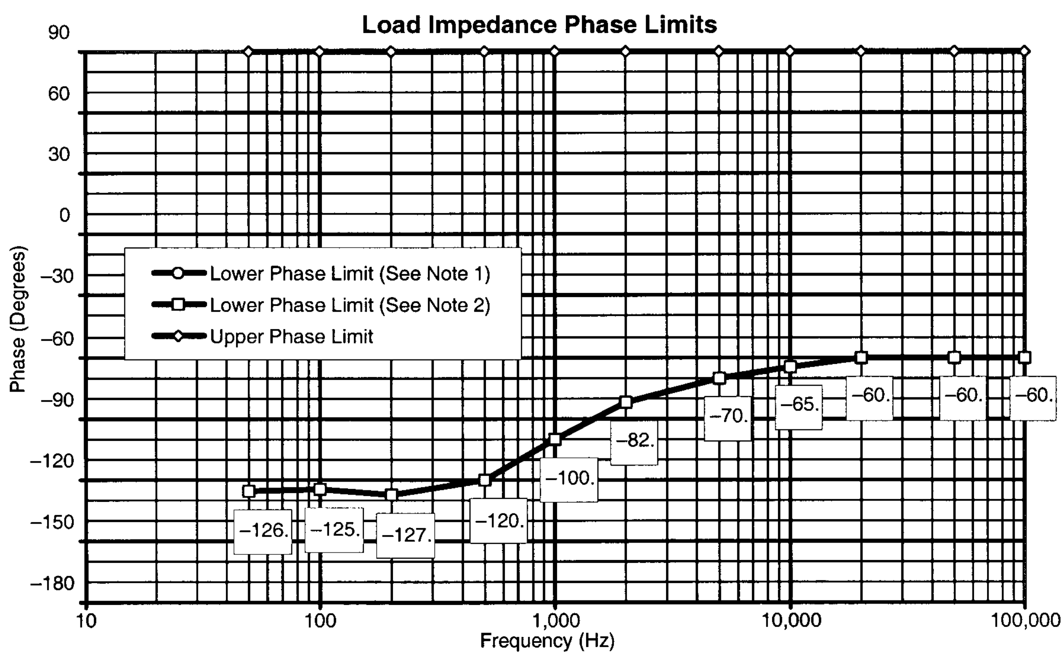
1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station and ISPR payload equipment accommodated in APM shall function correctly with a maximum current rate of rise of 100 amps/ms up to 40-amps peak surge current.

Figure 24. Maximum current rate of change versus peak surge current amplitude

Table XIII. Maximum reverse energy/current from downstream loads

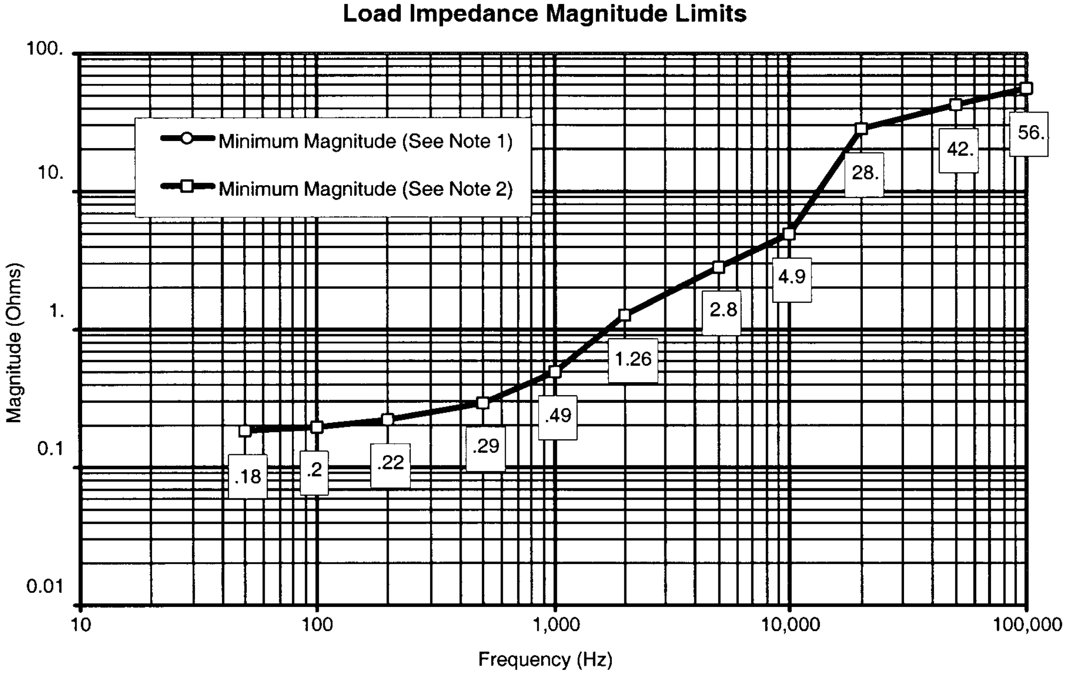
ISPR INTERFACE Power/RPCM type	MAXIMUM REVERSE ENERGY (Joules)	MAXIMUM REVERSE CURRENT (amps)		
		Pulse $t < 10\ \mu s$	Peak $t < 1$ ms	Steady State $t > 1$ s
3 kW / type VI	3.0	400	250	3
6 kW / type III	6.0	800	500	6
JEM	**(TBD #7)**	**(TBD #7)**	**(TBD #7)**	**(TBD #7)**
ESA	**(TBD #8)**	**(TBD #8)**	**(TBD #8)**	**(TBD #8)**
UOP Type I	1.5	400	250	2
UOP Type V	1.5	400	250	2
μs = microseconds ms = milliseconds s = second				

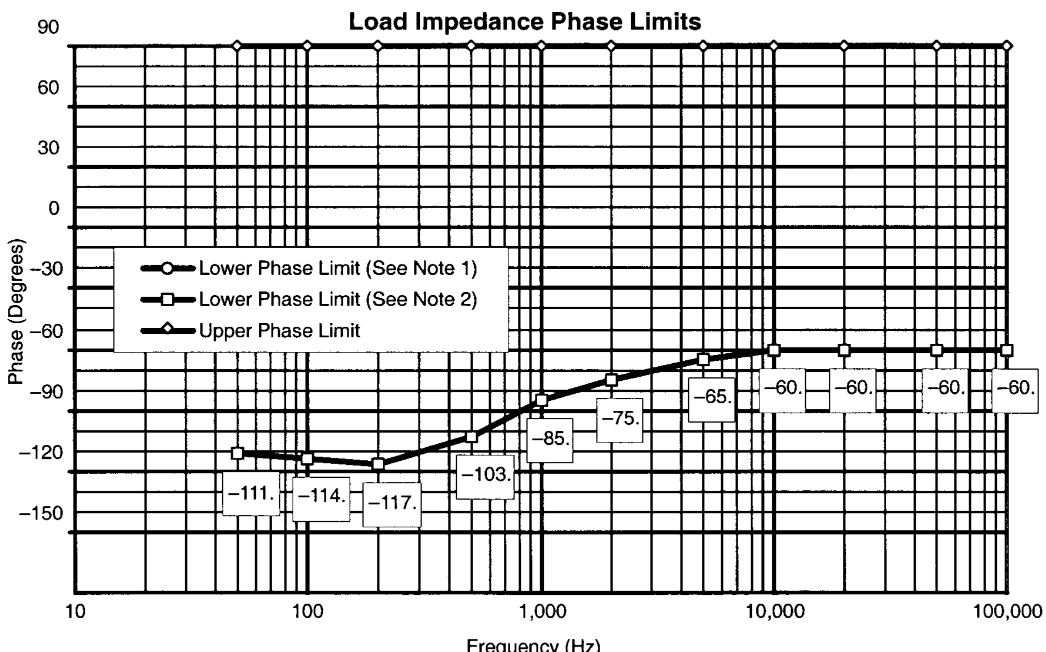




Notes:
1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.

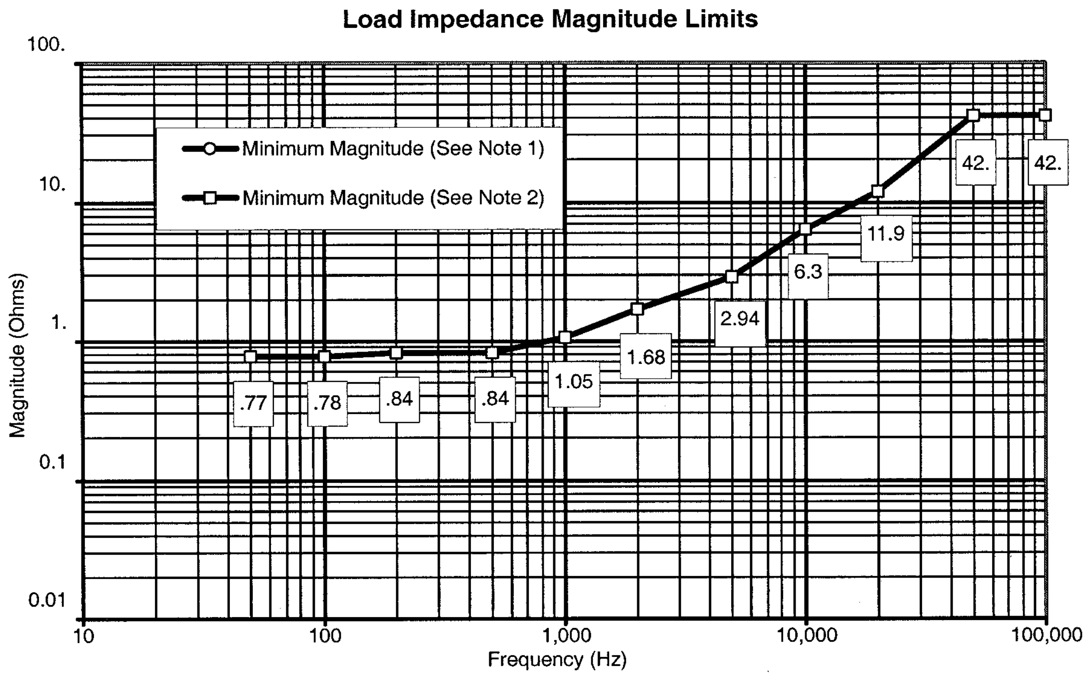
Figure 25. Interface B load impedance limits

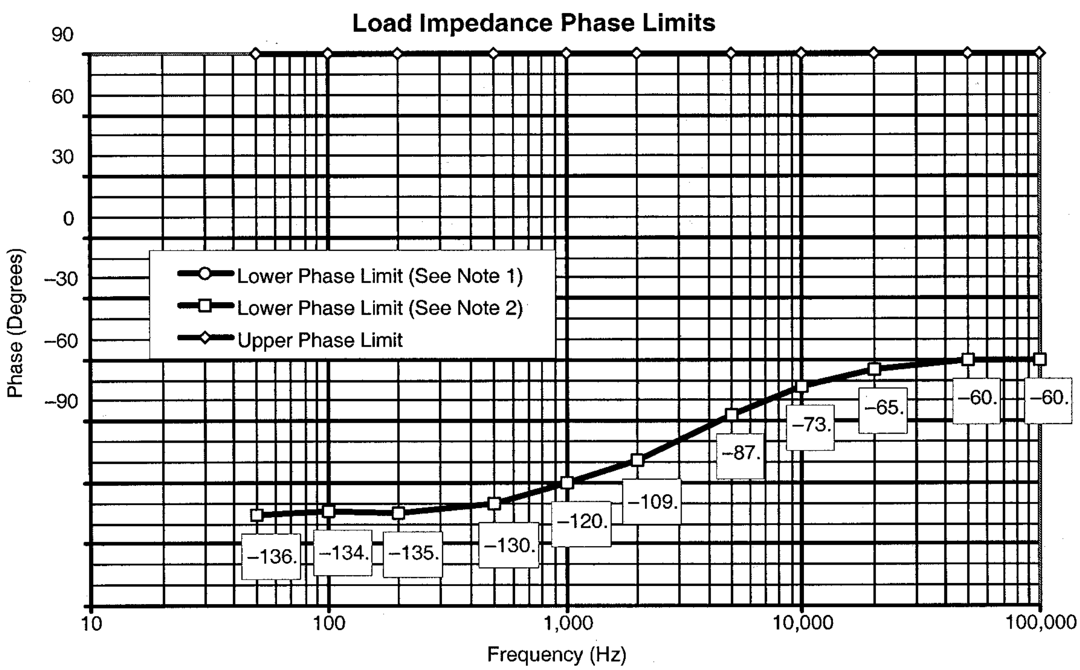




Notes:
1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.

Figure 26. 6 kw Interface B load impedance limits





Notes:
1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.

Figure 27. 1.2 to 1.44 kw auxiliary Inteface B load impedance limits

3.2.6.4.3.13 Large signal stability.

The CIR EPCE connected to Interface B shall maintain stability with the ISS EPS interface by damping a transient response to 10% of the maximum response amplitude within 1.0 ms, and remaining below 10% thereafter under the following conditions:

1. The rise time/fall time (between 10 and 90% of the amplitude) of the input voltage pulse is less than 10 μs.
2. The voltage pulse is to be varied from 100 to 150 μs in duration.

Note: Figure 28 is used to clarify the above requirement.

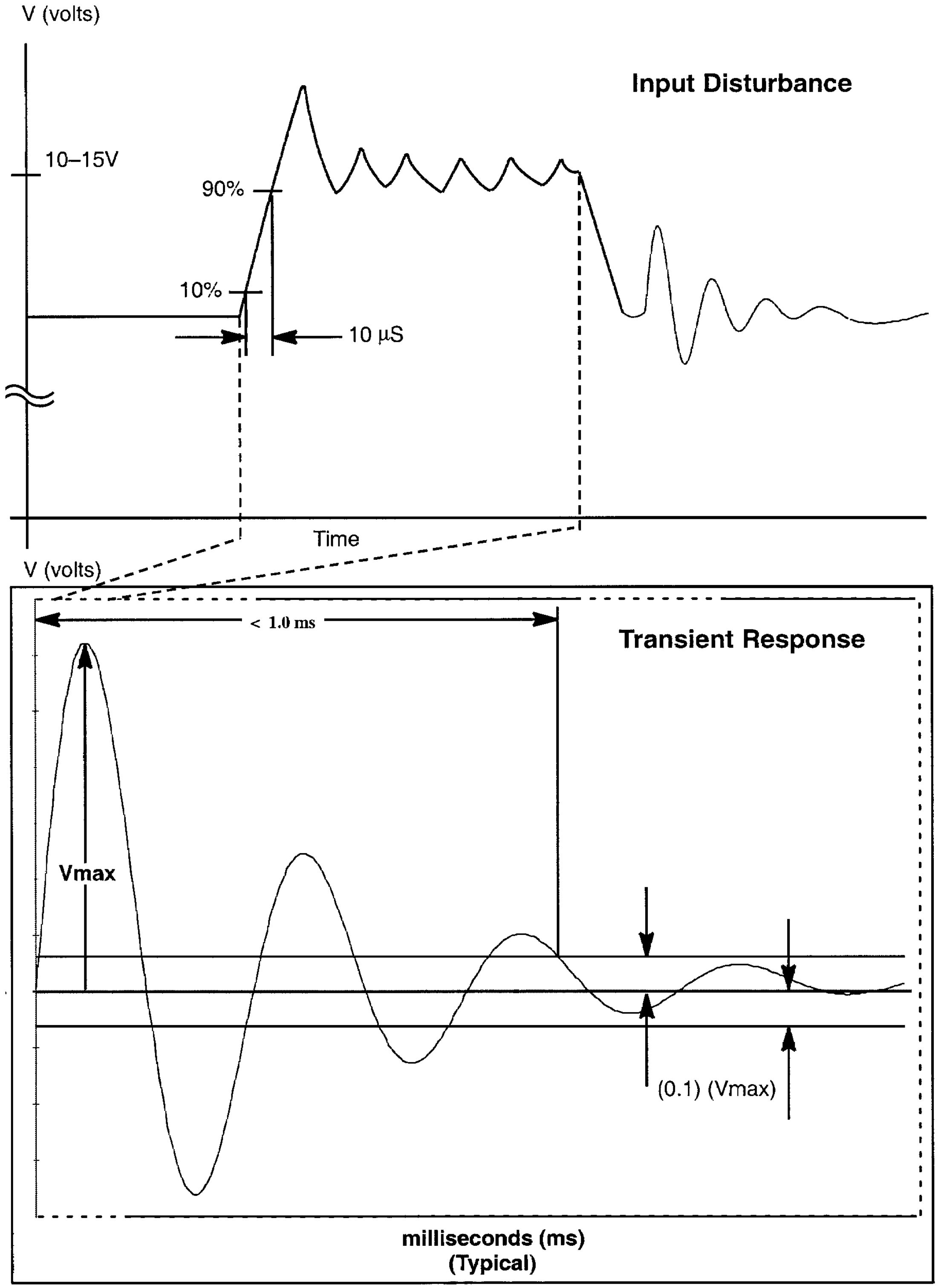


Figure 28. Pulse applied to the power input of the CIR

3.2.6.4.3.14 Maximum ripple voltage emissions.

The maximum ripple voltage induced on the power line by the CIR EPCE connected to Interface B shall be no greater than 0.5 V peak-to-peak.

3.2.6.4.3.15 Wire derating.

a. Derating criteria for EPCE at and downstream of the primary circuit protection device(s) in the CIR, as shown in Figure 29, shall be per NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038.
b. The CIR shall use 4 gauge wire for main and auxiliary connections at the UIP.

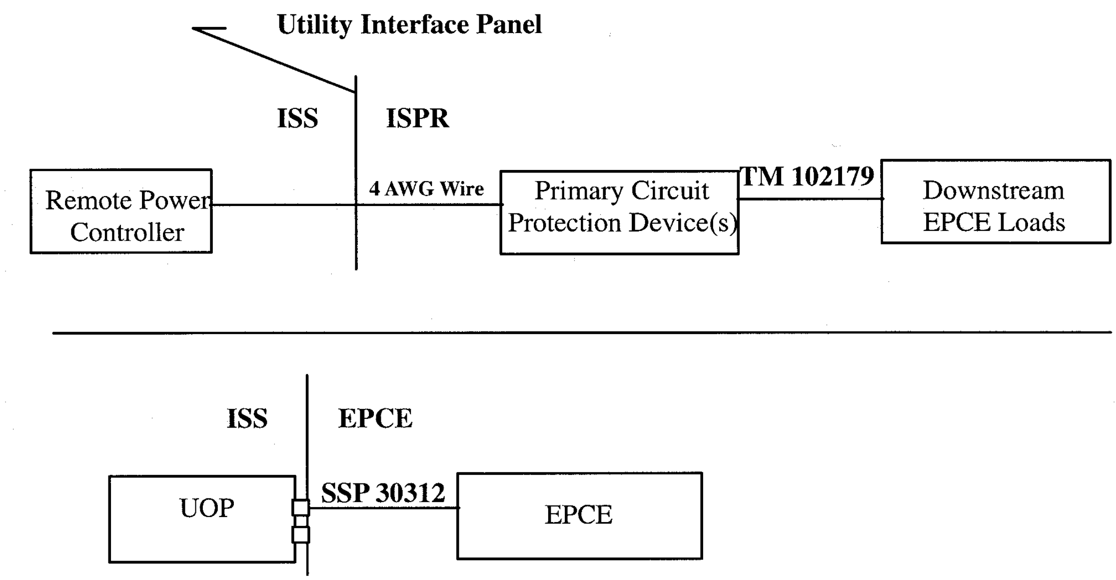


Figure 29. Wire derating requirements for CIR

3.2.6.4.3.16 Exclusive power feeds.

a. The CIR shall receive power only from the UIP dedicated to its rack location.
b. Cabling shall not occur between Interface C connected EPCE with Interface B; and/or Interface B connected EPCE with Interface C.

3.2.6.4.3.17 Loss of power.

The CIR shall fail safe in the event of a total or partial loss of power regardless of the availability of Auxiliary power in accordance with NSTS 1700.7, ISS Addendum.

3.2.6.4.3.18 Electromagnetic compatibility.

The CIR EPCE connected to Interface B shall meet the EMC requirements of SSP 30243, paragraphs 3.1 and 3.6.2.

3.2.6.4.3.18.1 Electrical grounding.

The CIR EPCE connected to Interface B shall meet all requirements specified in section 3 of SSP 30240.

3.2.6.4.3.18.2 Electrical bonding.

The CIR shall interface with the module bond strap per SSP 57001 Hardware ICD Template. Electrical bonding of EPCE connected to Interface B shall be in accordance with SSP 30245 and NSTS 1700.7 ISS Addendum, sections 213 and 220.

3.2.6.4.3.18.3 Cable/wire design and control requirements.

Cabling between CIR EPCE and Interface B shall meet all Cable and Wire Design requirements of SSP 30242.

3.2.6.4.3.18.4 Electromagnetic interference.

The CIR shall meet the requirements as specified in SSP 30237.

3.2.6.4.3.18.5 Electrostatic discharge.

The unpowered CIR and its components shall not be damaged by electrostatic discharge (ESD) equal to or less than 4,000 V to the case or any pin on external connectors. EPCE that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position.

3.2.6.4.3.18.6 Alternating current (ac) magnetic fields.

The generated ac magnetic fields, measured at a distance of 7 cm from the generating equipment, shall not exceed 140 dB above 1 pT for frequencies ranging from 30 Hz to 2 kHz, then falling 40 dB per decade to 50 kHz.

3.2.6.4.3.18.7 Direct current (dc) magnetic fields.

The generated dc magnetic fields shall not exceed 170 dB pT at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices.

3.2.6.4.3.18.8 Corona.

Electrical and electronic subsystems, equipment, and systems shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC–STD–531, High Voltage Design Criteria.

3.2.6.4.3.18.9 Lightning.

The CIR EPCE shall meet the lightning induced environment requirement in paragraph 3.2.8.1 of SSP 30243.

3.2.6.4.3.18.10 EMI susceptibility for safety-critical circuits.

Payload safety-critical circuits, as defined in SSP 30243, shall meet the margins defined in SSP 30243, paragraph 3.2.3.

3.2.7 Transportability.

The CIR shall be designed to be transportable within the United States without damage by truck or air via common commercial carrier when packaged as specified herein without requiring special accommodation to meet the transportation and handling limit load factors as specified in Table XIV.

Table XIV. Transportation and handling limit load factors

Mode	Load Occurrence	Fore/Aft g's	Lateral g's	Vertical g's
Air	I	±3.5	±2.0	+3.5/0.0
Truck/air ride trailer	I	±3.5	±2.0	+3.5/-1.5
Dolly(max velocity 8 km/h (5 mph))	I	±1.0	±0.75	+2.0/-0.0
Forklifting	S	±1.0	±0.75	+2.0/-0.0
Hoisting	I	1.5 in direction of travel		

Notes:
S - Loads occur simultaneously in the thee directions.
I – Loads occur independently in the thee directions except for gravity.
Above load factors act at the center of gravity of the cargo.
Cargo weighing <136 kgs. Subject to additional loads cause by vibroacoustics for applicable transportation modes.
For ground transportation, the structure/carrier vehicle should be designed for the occurrence of a 15.4 m/s wind in combination with the load factors.
Cargo support structure will be designed, or carrier operation constrained, or both to insure that cargo loads will not exceed the design load.
Limit load factors listed in this table may be superseded by limit load factors derived for specific transportation mode/vehicle, transportation handling fixtures and handling equipment.
Vertical g's are positive in the direction of gravity (downward).

3.2.7.1 CIR launch and return.

The CIR in its launch configuration and stowed CIR hardware shall be designed to withstand a minimum of two shuttle launches and landings in the MPLM.

3.3 Design and construction.

3.3.1 Materials, processes, and parts.

3.3.1.1 CIR specific material requirements.

3.3.1.1.1 Materials – general.

Materials used in the CIR shall meet the requirements as specified in paragraphs 208.3 and 209 of NSTS 1700.7, NSTS 1700.7 ISS Addendum, and FCF-PLN-0036.

3.3.1.1.2 Internal Thermal Control System (ITCS) Fluids.

a. The CIR shall use ITCS fluids that meet the requirements specified in SSP 30573.
b. The CIR shall meet the fluid system cleanliness levels specified in SSP 30573.
c. The CIR shall use internal materials that are compatible according to MSFC-SPEC-250, Table III or that will not create a potential greater than 0.25 V with the ISS system internal materials due to a dissimilar metal couple.

3.3.1.1.3 Connectors.

Connectors used in the CIR, external to the assembly level, shall consist of MIL-C-38999, MIL-C-5015, MIL-C-81569, MIL-C-83733, or SSQ 21635 as specified in SSP 30423, Figure 4.1-8.

3.3.1.1.4 External cleanliness.

a. The CIR external surfaces, with applicable PI hardware, shall conform prior to launch to Visibly Clean - Sensitive (VC - S) cleanliness requirements, as specified in SN-C-0005.
b. The CIR external surfaces, with applicable PI hardware, shall meet the minimum acceptable cleanliness environment as measured by the US Lab.

3.3.1.2 Toxic products and formulations.

The CIR shall meet the toxic product and formulation requirements as specified in FCF-PLN-0036.

3.3.1.3 Volatile organic compounds.

The CIR shall meet the volatile organic compound requirements as specified in FCF-PLN-0036.

3.3.1.4 Hazardous materials.

The CIR shall meet the hazardous material requirements as specified in FCF-PLN-0036.

3.3.1.5 Protective coatings.

The CIR shall meet the protective coating requirements as specified in FCF-PLN-0036.

3.3.2 Electromagnetic radiation.

3.3.2.1 Ionizing radiation.

Not applicable.

3.3.2.2 Nonionizing radiation.

Not applicable.

3.3.2.3 Operating environment.

Not applicable.

3.3.2.4 Generated environment.

Not applicable.

3.3.3 Nameplates and product marking.

3.3.3.1 Nameplates.

3.3.3.2 CIR identification and marking.

The CIR, all sub-rack elements (installed in the rack or separately), loose equipment, stowage trays, consumables, assemblies, crew accessible connectors and cables, switches, indicators, and controls shall be labeled as specified in SSP 57000 Appendix C.

3.3.3.2.1 CIR component identification and marking.

All CIR parts shall be legibly and permanently marked with a Part Identification Number (PIN) with the following exceptions:

a. Commercial-Off-the-Shelf (COTS) items marked with visible, permanent, and commercial identification.
b. Parts within a COTS assembly that are not subject to removal, replacement, or repair.
c. Parts within an assembly that are permanently installed and are not subject to removal, replacement, or repair.
d. Parts that cannot be physically marked or tagged due to lack of space or when marking would have a deleterious effect shall be temporarily tagged or packaged until the part is installed on the next higher assembly.

3.3.3.2.2 CIR lighting design.

a. CIR work surface specularity shall not exceed 20%. Paints listed in Table XV meet this requirement.
b. Lighting levels for tasks to be performed at CIR work sites shall be provided, as defined in Table XVI.
c. Medium CIR operational tasks shall utilize the ISS Portable Utility Light (PUL) specified in JSC 27199.
d. All text on surfaces intended to be read by the on orbit crew shall be black lusterless, 37038 as specified in FED-STD-595, on off-white, semi-gloss, 27722 background as specified in FED-STD-595.
e. All aluminum surfaces susceptible to wear shall be clear or black hard coat anodized or equivalent.
f. CIR components shall be exempt from the lighting design requirement if the surfaces are color coded to meet other requirements as specified herein, such as interior component surfaces, COTS components, fluid system tubing, and surfaces required by science or safety to exhibit specific characteristics.

Table XV. Surface interior colors and paints

HARDWARE DESCRIPTION	COLOR	FINISH	PAINT SPECIFICATION PER FED–STD–595
Equipment Rack Utility Panel Recess	White	Semigloss	27925
Equipment Rack Utility Panel Text Characters	Black	Lusterless	37038
International Std. Payload Rack Primary Structure	Off-White	Semigloss	27722
ISPR Utility Panel Recess	White	Semigloss	27925
ISPR Utility Panel Recess Text Characters	Black	Lusterless	37038
Functional Unit Rack (Primary Structure)	Off-White	Semigloss	27722
Functional Unit Utility Panel Recess (as applicable)	White	Semigloss	27925
Functional Unit Utility Panel Recess Text Characters	Black	Lusterless	37038
Rack Front Aisle Extensions	Off-White	Semigloss	27722
Ceiling Rack Face Plates	Off-White	Semigloss	27722
Port Rack Face Plates	Off-White	Semigloss	27722
Starboard Rack Face Plates	Off-White	Semigloss	27722
Floor Rack Face Plates	Off-White	Semigloss	27722
Ceiling Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Port Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Starboard Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Floor Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Stowage Trays	Off-White	Semigloss	27722
Stowage Tray Handle Straps (any location)	Blue material	Semigloss	25102 or equiv.
Common Seat Track Interface	Clear (Anodized)	Semigloss	none
Glovebox (Aluminum or Plastic)	Medium Gray	Gloss	16329 or 16373
Glovebox (Aluminum)	White	Gloss	17925
Glovebox (Aluminum or Plastic)	Off-White	Gloss	17722
Glovebox (Aluminum)	Tan	Gloss	10475
EXPRESS Program Rack Utility Panels	Off–White	Gloss	17875

Table XVI. CIR required illumination levels

Type of Task	Required Lux (Foot-Candles)*
Medium payload operations (not performed in the aisle) (e.g., payload change-out and maintenance)	325 (30)
Fine payload operations (e.g., instrument repair)	1075 (100)
Medium glovebox operations (e.g., general operations, experiment set-up)	975 (90)
Fine glovebox operations (e.g., detailed operations, protein crystal growth, surgery/dissection, spot illumination)	1450 (135)

* As measured at the task site

3.3.3.2.3 Touch temperature warning labels.

Warning labels shall be provided at the surface site of any CIR component that exceeds a temperature of 49°C (120°F), including surfaces not normally exposed to the cabin, in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2-95-048.

3.3.3.2.4 Connector coding and labeling.

a. Both halves of CIR mating connectors shall display a code or identifier which is unique to that connection.
b. The labels or codes on CIR connectors shall be located so they are visible when connected or disconnected.
c. Each CIR electrical connector pin shall be uniquely identifiable in each electrical plug and each electrical receptacle. At least every 10^{th} pin must be labeled.

3.3.3.3 Portable fire extinguisher (PFE) and fire detection indicator labeling.

a. The CIR shall label the Portable Fire Extinguisher (PFE) access port with a SDD32100397-002 “Fire Hole Decal” specified in JSC 27260.
b. The CIR shall label the Fire Detection Indicator Light Emitting Diode (LED) “SMOKE INDICATION” as specified in MSFC-STD-275, using 3.96 mm (0.156 in.) letters, style Futura Demibold, and color 37038 (Lusterless Black) per FED-STD-595.

3.3.3.4 Electrostatic discharge sensitive (ESD) parts labeling.

Labeling of EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL-STD-1686. These voltages are the result of charges that may be accumulated and discharged from ground personnel or crew members during equipment installation or removal.

3.3.4 Workmanship.

The CIR, with applicable PI hardware, shall conform to the workmanship standards in accordance with NHB 5300.4(1B).

3.3.5 Interchangeability.

All ORU’s that have the same part number shall be functionally and dimensionally interchangeable.

3.3.5.1 On orbit interchangeability.

The following assemblies and components shall be interchangeable on orbit:

a. IPP

b. IOP
c. EPCU
d. GC Assembly
e. GC Outlet Valve Assembly
f. FCU
g. IOP Disk Drives
h. Exhaust Pump Assembly
i. Exhaust Vent Manifold Assembly
j. Vent Manifold Assembly
k. Exhaust Manifold Assembly
l. MV4 Manifold Assembly
m. Fuel Manifold Assembly
n. Diluent/Pre-Mix Manifold Assembly
o. Static Mixer Assembly
p. High Pressure Oxygen Manifold Assembly
q. Nitrogen/High Pressure Manifold Assembly
r. All Temperature Sensors
s. All Pressure Sensors
t. All Solenoid Valve Coils
u. Bottle Assemblies
v. All Adsorber Cartridge Assemblies
w. All Diagnostic Modules/Packages
x. ATCS Air Filters

3.3.6 Safety.

The CIR, with applicable hardware and software, shall meet all applicable requirements of NSTS 1700.7 ISS Addendum.

3.3.6.1 Fire Prevention.

The CIR shall meet the fire prevention requirements specified in NSTS 1700.7 ISS Addendum, paragraph 220.10 a.

3.3.6.1.1 Smoke detector.

a. The CIR, which contains potential fire sources and has forced air circulation, shall use a smoke detector that meets the requirements specified in D683-10007 and SSP 30262:013.
b. The CIR shall provide a smoke detector interface at the J43 connection with interface characteristics meeting the requirements specified in paragraph 3.3.6.1.1.1.

3.3.6.1.1.1 Maintenance switch, smoke detector, smoke indicator, and CIR fan interfaces.

a. The CIR power off command interface characteristics shall be in accordance with Table XVII.

b. The CIR power cut-off shall be implemented with a manually operated two-position lever lock switch.

3.3.6.1.1.2 Smoke detector analog interface characteristics.

The electrical characteristics (signal source) of the active driver interface shall be in accordance with Table XVIII.

Table XVII. Bi-level data characteristics (switch contact)

PARAMETER	ENG. UNIT	ISPR
Type Transfer		Floating (Isolation resistance >1MΩ) dc coupled
I/F Resistance (closed)	Ω	< 20
I/F Resistance (open)	MΩ	> 1
Open Circuit Leakage Current	μA	0 to 100
Operating Current (closed)	mA	0.2 to 30
Minimum Open Circuit Voltage	V	20

Table XVIII. Electrical characteristics envelope of analog signals

PARAMETER	ENG. UNIT	ANALOG SIGNALS
TYPE	N/A	Balanced
TRANSFER	N/A	DC Coupled
ANALOG VOLTAGE (line to line)	V	–5 to +5
RIPPLE AND NOISE	mV Peak (1)	±20
CAPACITY (Maximum)	nF	N/A
IMPEDANCE	Ohm	≤1K
OVERVOLTAGE PROTECTION (Min)	V	±15
FAULT VOLTAGE EMISSION (Max)	V	±15
FAULT CURRENT LIMIT. (Maximum)	mA	±10 (2)

Notes: (1) Measurement Bandwidth ≥ 50 MHz
(2) ISPR AAA= 30mA max

3.3.6.1.1.3 Discrete command built-in-test interface characteristics.

The discrete command built-in-test (BIT) interface characteristics (signal source) shall be in accordance with Table XIX.

Table XIX. Electrical characteristics of bit interface

PARAMETER	ENG. UNIT	SMOKE SENSOR
TYPE	N/A	Single-Ended
TRANSFER	N/A	DC Coupled
I/F VOLTAGE (TRUE) (line to line)	V	<1.5
OPERATING CURRENT ON (TRUE) (Max)	mA	2
RIPPLE AND NOISE	mV Peak (1)	± 100
FAULT VOLTAGE EMISSION (Max)	V	± 5
FAULT CURRENT EMISSION (Max)	mA	5

Notes: (1) Measurement Bandwidth $\geq$ 50 MHz
(2) If interface is active (on or true)

3.3.6.1.1.4 Smoke indicator electrical interfaces.

The smoke indicator electrical interface characteristics shall be in accordance with Table XX.

Table XX. Smoke indicator interface characteristics

PARAMETER	ENG. UNIT	SMOKE INDICATOR
TYPE	N/A	Floating
TRANSFER	N/A	DC Coupled
LOAD CURRENT (max)	mA	10
OVERVOLTAGE PROTECTION RANGE	V	± 20
FAULT CURRENT EMISSION (max)	mA	24
IMPEDANCE (DC)	Ohm	>650

Note: At zero current rating (infinite load impedance)

3.3.6.1.1.5 Fan ventilation status electrical interfaces.

The CIR fan ventilation status electrical interface characteristics shall be in accordance with paragraph 3.3.6.1.1.2. The air is circulated though the smoke sensor in the CIR by a fan controlled and powered by the CIR.

3.3.6.1.1.6 Rack maintenance switch(rack power switch)/fire detection support interface connector.

a. CIR connector P43 mating requirements to the UIP Connector J43 shall be as specified in paragraph 3.1.5.1.
b. The CIR Maintenance Switch/FDS P43 Connector shall meet the pinout interfaces of the UIP J43 Connector as specified in SSP 57001, paragraph 3.3.6.
c. CIR Maintenance Switch/FDS P43 Connector shall meet the requirements of SSQ 21635 or equivalent.

3.3.6.1.2 Fire detection indicator.

a. The CIR shall provide a red Fire Detection Indicator LED in an easily visible location on the front of the rack that is powered by the ISS when the smoke detector senses smoke.
b. The CIR shall provide a fire detection indicator interface at the J43 connection with interface characteristics meeting the requirements specified in paragraph 3.3.6.1.1.1.

3.3.6.1.3 Forced air circulation indication.

The CIR shall provide a signal and data indicating whether or not the air flow specified in SSP 30262:013, paragraph 3.6.6 is being provided to the smoke detector when the smoke detector is in use.

3.3.6.1.4 Fire parameter monitoring in the CIR.

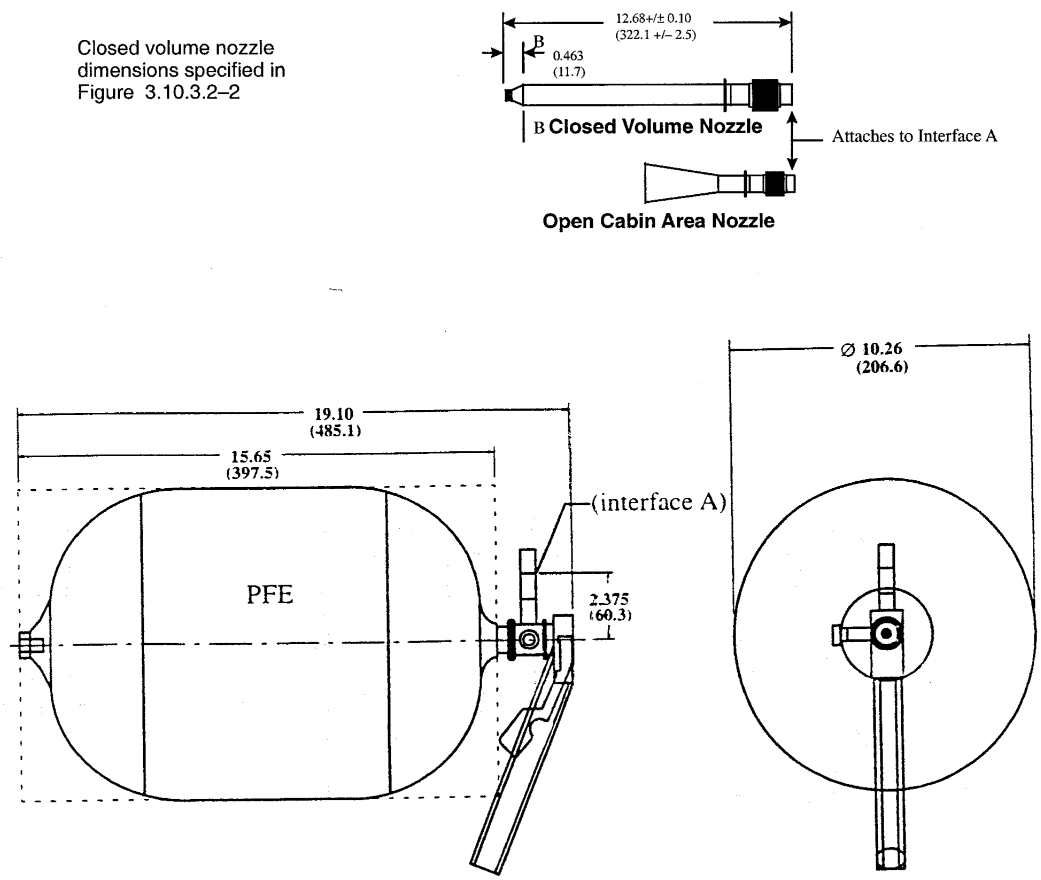
a. The CIR shall provide manual and automatic capabilities to terminate forced air circulation (if present) and power to the CIR.

   Note: Use of the Rack Maintenance Switch meets the manual requirement. For the CIR where the P/L Multiplexer-Demultiplexer (MDM) provides the monitoring function, the P/L MDM is capable of sending a command to the module Remote Power Controller (RPC) that will power off the CIR to meet the automatic requirement.

b. The CIR shall respond to an “out of bounds” condition by sending data to indicate the location and cause of the “out of bounds” condition to the payload MDM in the format specified in paragraph 3.4.1.1.5.4.

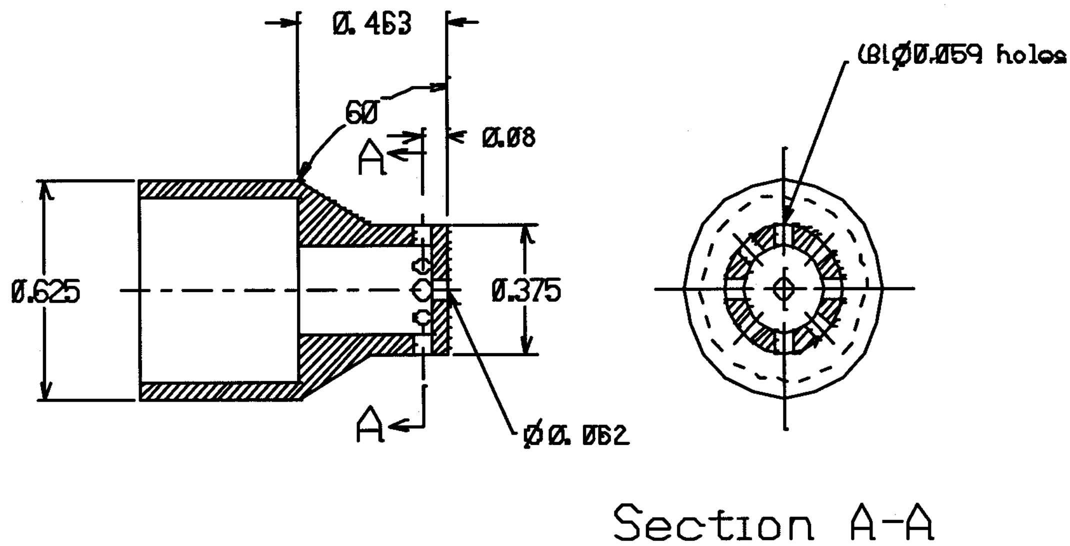
3.3.6.1.5 Fire suppression access port accessibility.

The CIR shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figure 30 and Figure 31 so the PFE nozzle can interface to the PFE port.



Note: Measurements from PFE centerline to point B with the closed cabin Nozzle attached is approximately 14.59 inches (370.6 mm)

Figure 30. Manual fire suppression hardware envelope



Note: Linear dimensions are in inches, angular dimensions are in degrees.

Figure 31. Closed volume PFE nozzle

3.3.6.1.6 Fire suppressant distribution.

The internal layout of the CIR shall allow ISS PFE fire suppressant to be distributed to the entire volume that PFE access port serves, lowering the oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute.

3.3.6.2 CIR front surface temperature.

The CIR shall be designed such that the average front surface temperature is less than 37°C (98.6°F) and partial limit not to exceed 49° C (120°F).

3.3.6.3 Electrical hazards.

CIR electrical equipment shall incorporate the following controls as specified below:

a. If the exposure condition is below the theshold for shock (i.e., below maximum leakage current and voltage requirements as defined within this section), no controls are required. Non-patient equipment with internal voltages not exceeding 30 Vrms or dc nominal (32 Vrms or dc maximum) will contain potentials below the theshold for electrical shock.
b. If the exposure condition exceeds the theshold for shock, but is below the theshold of the let-go current profile (critical hazard) as defined in Table XXI, two independent controls (e.g., a safety (green) wire, bonding, insulation, leakage current levels below maximum

requirements) shall be provided such that no single failure, event, or environment can eliminate more than one control.

c. If the exposure condition exceeds both the theshold for shock and the theshold of the let-go current profile (catastrophic hazardous events) as defined in Table XXI, thee independent controls shall be provided such that no combination of two failures, events, or environments can eliminate more than two controls.

d. If two dependent controls are provided, the physiological effect that a crew member experiences as a result of the combinations of the highest internal voltage applied to or generated within the equipment and the frequency and wave form associated with a worst case credible failure shall be below the theshold of the let-go current profile as defined in Table XXI.

e. If it cannot be demonstrated that the hazard meets the conditions of paragraph a, b, or c above, thee independent hazard controls shall be provided such that no combination of two failures, events, or environments can eliminate more than two controls.

Table XXI. Let-go current profile theshold versus frequency

Frequency (Hertz)	Maximum Total Peak Current (AC + DC components combined) (milliamperes)
DC	40
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
10000	24.3
50000	24.3
(Based on 99.5 Percentile Rank of Adults)	

3.3.6.4 Connector mating.

a. The design of electrical connectors shall make it impossible to inadvertently reverse a connection or mate the wrong connectors if a hazardous condition can be created.

b. CIR and on orbit support equipment, wire harnesses, and connectors shall be designed such that no blind connections or disconnections must be made during CIR installation, operation, removal, or maintenance on orbit unless the design includes scoop proof connectors or other protective features (NSTS 1700.7 ISS Addendum, paragraph 221).

c. CIR equipment, for which mismating or cross-connection may damage ISS-provided equipment, plugs, and receptacles (connectors), shall be selected and applied such that it cannot be mismatched or cross-connected in the intended system as well as adjacent systems.

Although identification markings or labels are required, the use of identification alone is not sufficient to preclude mismating.

d. For all other CIR connections, combinations of identification, keying and clocking, and equipment test, and checkout procedures shall be employed at the payload's discretion to minimize equipment risk while maximizing on orbit operability.

3.3.6.5 Mating/demating of powered connectors.

The CIR EPCE shall meet the electrical safety requirements as defined in NSTS 1700.7 ISS Addendum. Payloads shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-97-093.

Note: The module can provide one verifiable upstream inhibit which removes voltage from the UIP and UOP connectors. The module design will provide the verification of the inhibit status at the time the inhibit is inserted.

3.3.6.6 Safety-critical circuit redundancy.

The CIR EPCE shall meet the electrical safety requirements as defined in NSTS 1700.7 ISS Addendum. The CIR EPCE connected to Interface B shall meet the safety-critical circuits redundancy requirements defined in NSTS 18798.

3.3.6.7 Rack maintenance switch (rack power switch).

The CIR shall provide a guarded, two-position, manually operated switch installed in a visible and accessible location on the front of the CIR that removes all power to the CIR.

3.3.6.8 Power switches/controls.

The following power switches/controls requirements apply to power to power interfaces with open circuit voltage exceeding 30 Vrms or dc nominal (32 Vrms or dc maximum).

a. Switches/controls performing on/off power functions for all power interfaces shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position.
b. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit.
c. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition.

3.3.6.9 Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage.

a. A non-portable utility outlet with output voltages exceeding 30 Vrms or dc nominal (32 Vrms or dc maximum) intended to supply power to portable equipment shall include a GFCI, as an electrical hazard control, in the power path to the portable equipment.

b. GFCI trip current dc detection shall be independent of the portable equipment's safety (green) wire.
c. GFCI trip current ac detection shall be dependent on the portable equipment's safety (green) wire when the safety (green) wire is present.
d. Portable equipment that has internal voltages greater than 30 Vrms or dc nominal (32 Vrms or dc maximum) and has a credible fault path or return path to a crew member shall include GFCI protection for that credible path with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table XXI.
e. GFCI will be designed to trip below the theshold of let-go based upon the 99.5 percentile rank of adults. Non-portable utility outlets supplying power to portable equipment shall include a GFCI with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table XXI.
f. GFCI's shall remove power within 25 ms upon encountering the fault current.
g. GFCI shall provide an on orbit method for testing trip current detection theshold at dc and at a frequency within the maximum human sensitivity range of 15 to 70 Hz.

3.3.6.10 Portable equipment/power cords.

a. Non-battery powered portable equipment shall incorporate a thee-wire power cord.
b. Fault currents resulting from a single failure within a non-battery powered portable equipment that has internal voltage above 30 Vrms or dc nominal (32 Vrms or dc maximum) and has a credible fault path or return path to the crew member shall not exceed the total peak currents specified in Table XXI for fault current frequencies of 15 Hz and above.

3.3.6.11 Overload protection.

3.3.6.11.1 Device accessibility.

An overload protective device shall not be accessible without opening a door or cover, except that an operating handle or operating button of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure.

3.3.6.11.2 Extractor-type fuse holder.

The design of the extractor-type fuse holder shall be such that the fuse is extracted when the cap is removed.

3.3.6.11.3 Overload protection location.

Overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on orbit shall be located where they can be seen and replaced or reset without removing other components.

3.3.6.11.4 Overload protection identification.

Each overload protector (fuse or circuit breaker) intended to be manually replaced or physically reset on orbit shall be readily identified or keyed for its proper value.

3.3.6.11.5 Automatic restart protection.

Controls shall be employed that prevent automatic restarting after an overload-initiated shutdown.

3.3.6.12 Sharp edges and corners protection.

The CIR design shall protect crew members from sharp edges and corners during all crew operations in accordance with NSTS 1700.7 ISS Addendum, paragraph 222.1.

3.3.6.13 Holes.

Holes that are round or slotted in the range of 10.0 to 25.0 mm (0.4 to 1.0 in.) shall be covered.

3.3.6.14 Latches.

Latches that pivot, retract, or flex so that a gap of less than 35 mm (1.4 in.) exists shall be designed to prevent entrapment of a crew member’s appendage.

3.3.6.15 Screw and bolts.

Theaded ends of screws and bolts accessible by the crew and extending more than 3.0 mm (0.12 in.) shall be capped to protect against sharp theads.

3.3.6.16 Securing pins.

Securing pins shall be designed to prevent their inadvertently backing out above the handhold surface.

3.3.6.17 Levers, cranks, hooks, and controls.

Levers, cranks, hooks, and controls shall not be located where they can pinch, snag, or cut the crew members or their clothing.

3.3.6.18 Burrs.

Exposed surfaces shall be free of burrs.

3.3.6.19 Locking wires.

a. Safety wires shall not be used on fasteners which must be unfastened for on orbit removal or replacement.
b. All fracture-critical fasteners as defined in SSP 52005 (paragraph 5.6, Fastener Requirements, and Appendix B, Glossary of Terms), which must be unfastened for on orbit removal or replacement shall be safety cabled or cotter pinned.

3.3.6.20 Audio devices (displays).

a. The design of audio devices (displays) and circuits shall protect against false alarms.
b. All audio device (displays) shall be equipped with circuit test devices or other means of operability testing.
c. An interlocked, manual disable shall be provided if there is any failure mode which can result in a sustained activation of an audio device (display).

3.3.6.21 Egress.

All CIR egress requirements shall be in accordance with 1700.7 ISS Addendum, paragraph 205.

3.3.6.22 Failure tolerance.

The CIR shall be single fault tolerant for the operation of a computer to identify failures to allow for active troubleshooting.

3.3.6.23 Failure propagation.

a. The CIR shall be designed such that a failure within an assembly will not induce any failure external to the failed assembly.
b. The CIR shall be designed such that a failure within the CIR will not induce a failure to any system or component external to the CIR.

3.3.6.24 Separation of redundant paths.

Alternate or redundant electrical functional paths shall be provided for all paths where electrical or electronic harnesses cannot be replaced on orbit.

3.3.6.25 Incorrect equipment installation.

The CIR assemblies and components that are replaceable on orbit shall contain physical provisions to preclude incorrect installation which may result in damage to equipment or hazardous conditions.

3.3.6.26 Chemical releases.

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1 a. and 209.1 b. in NSTS 1700.7 ISS Addendum.

3.3.6.27 Single event effect (SEE) ionizing radiation.

The CIR, with applicable PI hardware, shall be designed not to produce an unsafe condition or one that could cause damage to equipment external to the CIR as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils).

3.3.6.28 Potential hazardous conditions.

a. The CIR shall determine if any out-of-tolerance conditions will lead to a hazardous condition and take steps necessary to prevent the hazardous condition.

b. Any autonomous reconfigurations performed to prevent a hazardous condition from occurring shall be capable of being overridden.

3.3.6.29 Withstand external environment.

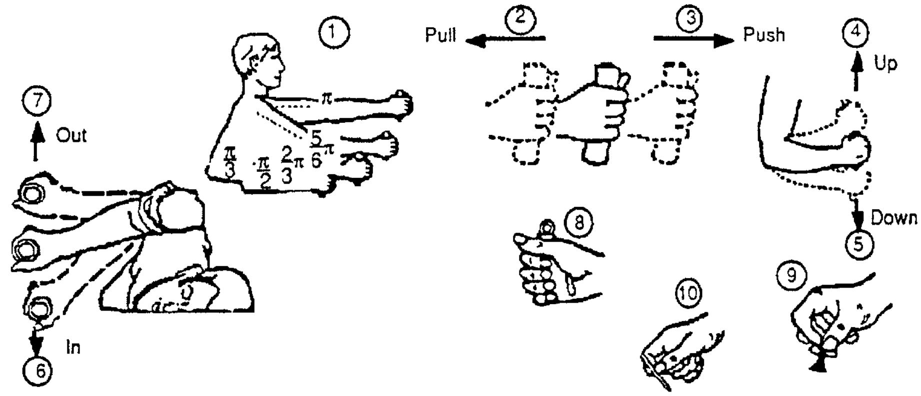
The CIR shall be designed to withstand changes in its external environment to prevent hazardous conditions within the CIR from occurring internal or external to the CIR.

3.3.7 Human performance/human engineering.

3.3.7.1 Strength requirements.

Forces and torques required to remove, replace, operate, control, and maintain CIR hardware and equipment on orbit shall be equal to or less than the strength values given below.

a. For operation and control of CIR hardware equipment:
   1. Grip Strength – To remove, replace, and operate CIR hardware, grip strength required shall be less than 254 N (57 lbf).
   2. Linear Forces – Linear forces required to operate or control CIR hardware or equipment shall be less than the strength values for the 5^{th} percentile female, defined as 50% of the strength values shown in Figure 32 and 60% of the strength values shown in Figure 33.
   3. Torques – Torques required to operate or control CIR hardware or equipment shall be less than the strength values for the 5^{th} percentile female, defined as 60% of the calculated 5^{th} percentile male capability shown in Figure 34.
b. Forces required for maintenance of CIR hardware and equipment shall be less than the 5^{th} percentile male strength values shown in Figure 32, Figure 33, Figure 34, Figure 35, Figure 36, and Figure 37.



Arm strength (N)												
(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (rad)	Pull		Push		Up		Down		In		Out	
	L**	R**	L	R	L	R	L	R	L	R	L	R
π	222	231	187	222	40	62	58	76	58	89	36	62
5/6 π	187	249	133	187	67	80	80	89	67	89	36	67
2/3 π	151	187	116	160	76	107	93	116	89	98	45	67
1/2 π	142	165	98	160	76	89	93	116	71	80	45	71
1/3 π	116	107	96	151	67	89	80	89	76	89	53	76

Hand and thumb-finger strength (N)				
	(8)		(9)	(10)
	Hand grip		Thumb-finger grip (Palmer)	Thumb-finger grip (tips)
	L	R		
Momentary hold	250	260	60	60
Sustained hold	145	155	35	35

* Elbow angle shown in radians
** L = Left; R = Right

Arm strength (lb)												
(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (deg)	Pull		Push		Up		Down		In		Out	
	L	R*	L	R	L	R	L	R	L	R	L	R
180	50	52	42	50	9	14	13	17	13	20	8	14
150	42	56	30	42	15	18	18	20	15	20	8	15
120	34	42	26	36	17	24	21	26	20	22	10	15
90	32	37	22	36	17	20	21	26	16	18	10	16
60	26	24	22	34	15	20	18	20	17	20	12	17

Hand, and thumb-finger strength (lb)				
	(8)		(9)	(10)
	Hand grip		Thumb-finger grip (Palmer)	Thumb-finger grip (tips)
	L	R		
Momentary hold	56	59	13	13
Sustained hold	33	35	8	8

* Left; R = Right

Figure 32. Arm, hand, and thumb/finger strength (5th percentile male data)

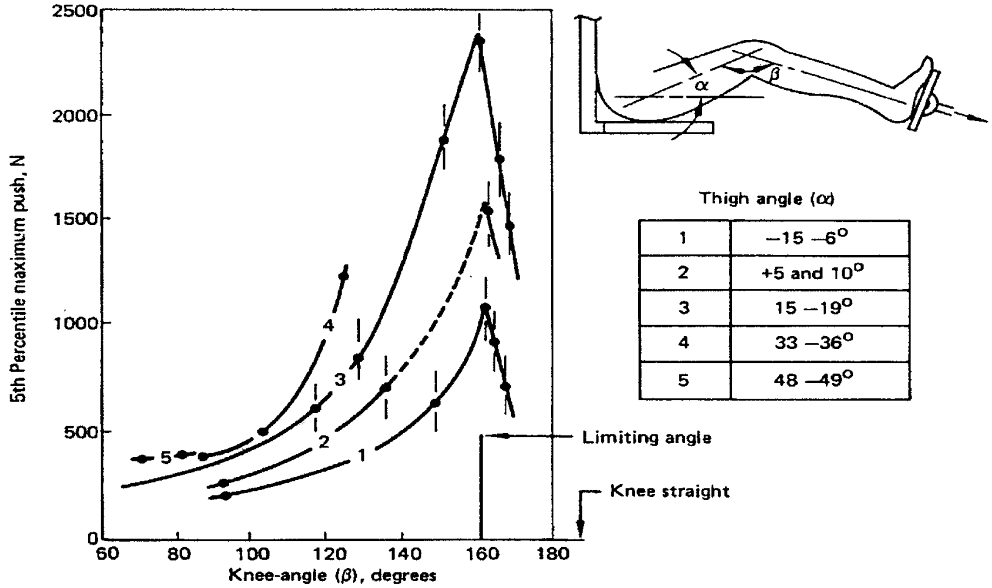


Figure 33. Leg strength at various knee and thigh angles (5th percentile male data)

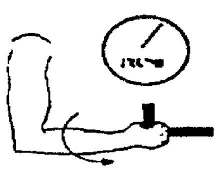
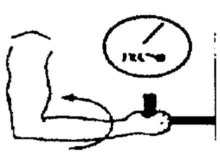
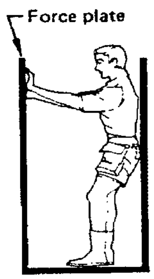
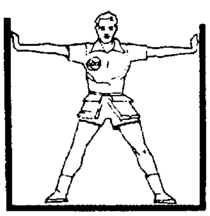
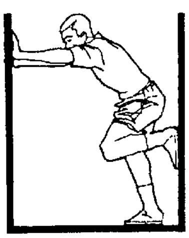
		Unpressurized suit, bare handed	
		Mean	SD
	Maximum torque: Suppination, Nm (lb-in.)	13.73 (121.5)	3.41 (30.1)
	Maximum torque: Pronation, Nm (lb-in.)	17.39 (153.9)	5.08 (45.0)

Figure 34. Torque strength

	Force-plate (1) height	Distances (2)	Force, N (lbf) Means	Force, N (lbf) SD
			Both hands	
	100 percent of shoulder height	50	583 (131)	142 (32)
		60	667 (150)	160 (36)
		70	983 (221)	271 (61)
		80	1285 (289)	400 (90)
		90	979 (220)	302 (68)
		100	645 (145)	254 (57)
			Preferred hand	
		50	262 (59)	67 (15)
		60	298 (67)	71 (16)
		70	360 (81)	98 (22)
		80	520 (117)	142 (32)
		90	494 (111)	169 (38)
		100	427 (96)	173 (39)
		Percent of thumb-tip reach *		
	100 percent of shoulder height	50	369 (83)	138 (31)
		60	347 (78)	125 (28)
		70	520 (117)	165 (37)
		80	707 (159)	191 (32)
		90	325 (73)	133 (30)
		Percent of span **		

	Force-plate (1) height	Distances (2)	Force, N (lbf) Means	Force, N (lbf) SD
	50	100	774 (174)	214 (48)
	50	120	778 (175)	165 (37)
	70	120	818 (184)	138 (31)
	Percent of shoulder height		1-g applicable data	

NOTES:

(1) Height of the center of the force plate - 200 mm (8 in) high by 254 mm (10 in) long - upon which force is applied.

(2) Horizontal distance between the vertical surface of the force plate and the opposing vertical surface (wall or footrest, respectively) against which the subject brace themselves.

() Thumb-tip reach - distance from backrest to tip of subject's thumb as thumb and fingertips are pressed together.

() Span - the maximal distance between a person's fingertips as he extends his arms and hands to each side.

(3) 1-g data.

Figure 35. Maximal static push forces

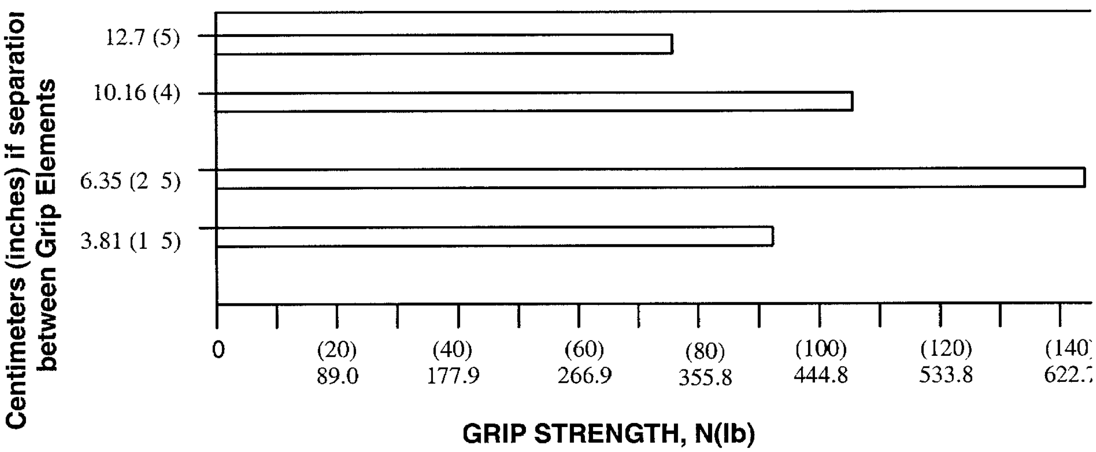


Figure 36. Male grip strength as a function of the separation between grip elements

3.3.7.2 Adequate crew clearance.

The CIR shall provide clearance for the crew to perform installation, operations, and maintenance tasks, including clearance for hand access, tools, and equipment used in these tasks.

3.3.7.3 Accessibility.

a. CIR hardware shall be geometrically arranged to provide physical and visual access for all CIR installation, operations, and maintenance tasks.
b. IVA clearances for finger access shall be provided as given in Figure 37.

Minimal finger-access to first joint			
Push button access:	Bare hand: Thermal gloved hand:	32 mm dia (1.26 in) 38 mm dia (1.5 in)	
Two finger twist access:	Bare hand: Thermal gloved hand:	object plus 50 mm (1.97 in) object plus 65 mm (2.56 in)	

Figure 37. Minimum sizes for access openings for fingers

3.3.7.4 Full size range accommodation.

All CIR work stations and hardware having crew nominal operations and planned maintenance shall be sized to meet the functional reach limits for the 5th percentile Japanese female and yet shall not constrict or confine the body envelope for the 95th percentile American male as specified in SSP 50005, section 3.

3.3.7.5 Housekeeping closures and covers.

Closures or covers shall be provided for any area of the payload that is not designed for routine cleaning.

3.3.7.6 Built-in housekeeping control.

a. CIR containers of liquids or particulate matter shall have built-in equipment/methods for control of vaporization, material overflow, or spills.
b. The capture elements, including grids, screens, or filter surfaces shall be accessible for replacement or cleaning without dispersion of the trapped materials.

3.3.7.7 One-handed operation.

Cleaning equipment and supplies shall be designed for one-handed operation or use.

3.3.7.8 Acoustic Requirements.

3.3.7.8.1 Continuous noise limits.

The Continuous Noise Source (see Appendix B, Definitions) for the CIR (including any supporting adjunct active portable equipment operated outside the CIR that is within or interfacing with the crew habitable volume) whose sub-rack equipment will be changed out on orbit shall not, except in those cases when the rack meets the Intermittent Noise Source requirements specified in SSP 57000, paragraph 3.12.3.3.2, exceed the limits specified in Table XXII for all octave bands (NC-40 equivalent) when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under nominal crew, or hardware operation circumstances, during CIR setup operations, or during nominal operations where doors/panels are opened or removed.

Note: These acoustic requirements do not apply during failure or maintenance operations.

3.3.7.8.2 Intermittent noise limits.

The CIR (including any supporting adjunct active portable equipment operated outside the CIR that is within or interfacing with the crew habitable volume) Intermittent Noise Source (See Appendix B, Definitions) shall not exceed the Total Rack A-weighted SPL Limits during the Maximum Rack Noise Duration as specified in Table XXIII when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under any planned operations.

Note: These acoustic requirements do not apply during failure or maintenance operations.

Rack Noise Limits Measured At 0.6 Meters Distance From The Test Article	
Frequency Band Hz	Integrated Rack Sound Pressure Level (SPL)
63	64
125	56
250	50
500	45
1000	41
2000	39
4000	38
8000	37

Table XXII. Continuous noise limits

Table XXIII. Intermittent noise limits

Rack Noise Limits Measured at 0.6 meters distance from the test article	
Maximum Rack Noise Duration Ü	Total Rack A-weighted SPL (dBA)
8 Hours	49
7 Hours	50
6 Hours	51
5 Hours	52
4 Hours	54
3 Hours	57
2 Hours	60
1 Hour	65
30 Minutes	69
15 Minutes	72
5 Minutes	76
2 Minutes	78
1 Minute	79
Not Allowed	80

The Rack Noise Duration is the total time that the rack produces intermittent noise above the NC-40 limit during a 24-h time period. This duration is the governing factor in determining the allowable Intermittent Noise Limits. Regardless of the number of separate sources and varying durations within a rack, this cumulative duration shall be used to determine the A-weighted SPL limit in column B.

For example, if a rack produces 65 dBA for 30 min in a start-up and warm-up mode and then settles down to 60 dBA for a 1-h period of normal data acquisition, the duration is 1.5 h. To meet the requirement, the noise can be no greater than 60 dBA, and in this case, the rack would not meet the requirement, even though two separate payloads, one that operated at 65 dBA for 30 min and another that operated at 60 dBA for 1 h, would be acceptable (see Figure 38).

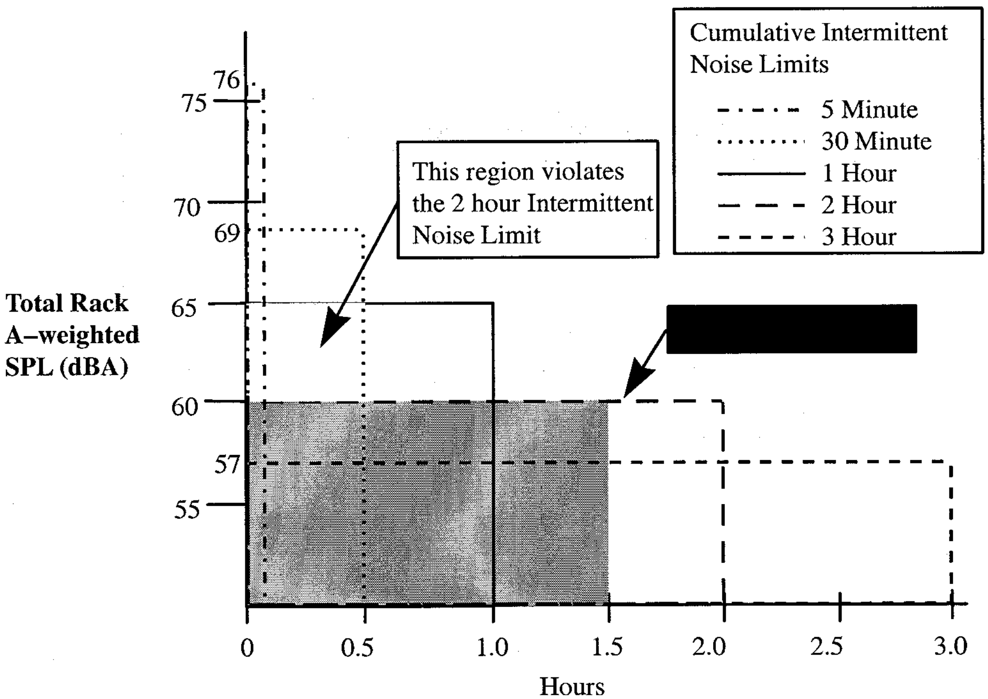


Figure 38. Intermittent noise limits

3.3.7.9 CIR hardware mounting.

3.3.7.9.1 Equipment mounting.

Equipment items used during nominal operations and planned maintenance shall be designed, labeled, or marked to protect against improper installation.

3.3.7.9.2 Drawers and hinged panel.

CIR assemblies which are pulled out of their installed positions for routine checkout shall be mounted on equipment drawers or on hinged panels. Such drawers or hinged panels shall remain in the "open" position without being supported by hand.

3.3.7.9.3 Alignment.

CIR hardware having blind mate connectors shall provide guide pins or their equivalent to assist in alignment of hardware during installation.

3.3.7.9.4 Slide-out stops.

Limit stops shall be provided on slide or pivot mounted CIR hardware which is required to be pulled out of its installed positions.

3.3.7.9.5 Push-pull force.

CIR hardware mounted into a capture-type receptacle that requires a push-pull action shall require a force less than 156 N (35 lbf) to install or remove.

3.3.7.9.6 Access.

Access to inspect or replace a hardware item (e.g., an assembly) which is planned to be accessed on a daily or weekly basis shall not require removal of another hardware item or more than one access cover.

3.3.7.9.7 Covers.

Where physical access is required, one of the following practices shall be followed, with the order of preference given:

a. Provide a sliding or hinged cap or door where debris, moisture, or other foreign materials might otherwise create a problem.
b. Provide a quick-opening cover plate if a cap will not meet stress requirements.

3.3.7.9.8 Self-supporting covers.

All access covers that are not completely removable shall be self-supporting in the open position.

3.3.7.9.9 Unique tools.

Payload provided unique tools shall meet the requirements of SSP 50005, paragraph 11.2.3.

3.3.7.10 Connectors.

3.3.7.10.1 One-handed operation.

All assembly connectors, whether operated by hand or tool, shall be designed and placed so they can be mated/demated using either hand.

3.3.7.10.2 Accessibility.

a.
   1. Nominal Operations – It shall be possible to mate/demate individual connectors without having to remove or mate/demate other connectors.
   2. Maintenance Operations – It shall be possible to mate/demate individual connectors without having to remove or mate/demate connectors on other assemblies or payloads.

b. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors.

3.3.7.10.3 Ease of disconnect.

a. Electrical connectors which are mated/demated during nominal operations shall require no more than two turns to disconnect.
b. Electrical connectors which are mated/demated only during assembly replacement operations shall require no more than six turns to disconnect.

3.3.7.10.4 Indication of pressure/flow.

CIR liquid or gas lines not equipped with quick disconnect connectors which are designed to be connected/disconnected under pressure shall be fitted with pressure/flow indicators.

3.3.7.10.5 Self locking.

Payload electrical connectors shall provide a self-locking feature.

3.3.7.10.6 Connector arrangement.

a. Space between connectors and adjacent obstructions shall be a minimum of 25 mm (1 in.) for IVA access.
b. Connectors in a single row or staggered rows which are removed sequentially by the crew (IVA) shall provide 25 mm (1 in.) of clearance from other connectors and/or adjacent obstructions for 270 degrees of sweep around each connector beginning at the start of its removal/replacement sequence.

3.3.7.10.7 Arc containment.

Electrical connector plugs shall be designed to confine/isolate the mate/demate electrical arcs or sparks.

3.3.7.10.8 Connector protection.

Protection shall be provided for all demated connectors against physical damage and contamination.

3.3.7.10.9 Connector shape.

CIR external and internal connectors shall use different connector shapes, sizes, or keying to prevent mating connectors when lines differ in content.

3.3.7.10.10 Fluid and gas line connectors.

Fluid and gas connectors that are mated and demated on orbit shall be located and configured so that they can be fully inspected for leakage.

3.3.7.10.11 Alignment marks or pin guides.

Mating parts shall have alignment marks in a visible location during mating or guide pins (or their equivalent).

3.3.7.10.12 Orientation.

Grouped plugs and receptacles shall be oriented so that the aligning pins or equivalent devices are in the same relative position.

3.3.7.10.13 Hose/cable restraints.

a. The CIR shall provide a means to restrain the loose ends of hoses and cables.
b. Conductors, bundles, or cables shall be secured by means of clamps unless they are contained in wiring ducts or cable retractors.
c. Cables shall be bundled if multiple cables are running in the same direction and the bundling does not cause electromagnetic interference (EMI).
d. Loose cables (longer than 0.33 m (1 ft) shall be restrained as follows:

Length (m)	Restraint Pattern ((% of length) tolerances +/– 10%)
0.33–1.00	50
1.00–2.00	33, 67
2.00–3.00	20, 40, 60, 80
>3.00	at least each 0.5 m

3.3.7.11 Fasteners.

3.3.7.11.1 Non-theaded fasteners status indication.

An indication of correct engagement (hooking, latch fastening, or proper positioning of interfacing parts) of non-theaded fasteners shall be provided.

3.3.7.11.2 Mounting bolt/fastener spacing.

Clearance around fasteners to permit fastener hand theading (if necessary) shall be a minimum of 0.5 in. for the entire circumference of the of the bolt head and a minimum of 1.5 in. over 180 degrees of the bolt head and provide the tool handle sweep as seen in Figure 39.

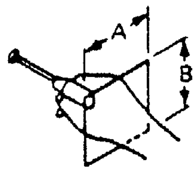
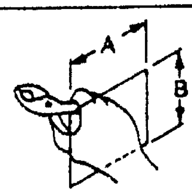
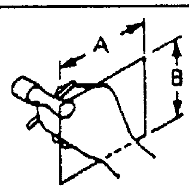
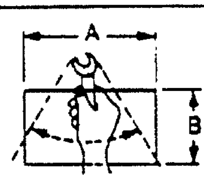
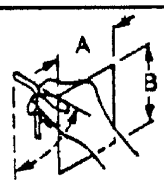
Opening dimensions		Task
	A 117 mm (4.6 in) B 107 mm (4.2 in)	Using common screw-driver with freedom to turn hand through 180 °
	A 133 mm (5.2 in) B 115 mm (4.5 in)	Using pliers and similar tools
	A 155 mm (6.1 in) B 135 mm (5.3 in)	Using T-handle wrench with freedom to turn wrench through 180°
	A 203 mm (8.0 in) B 135 mm (5.3 in)	Using open-end wrench with freedom to turn wrench through 62°
	A 122 mm (4.8 in) B 155 mm (6.1 in)	Using Allen-type wrench with freedom to turn wrench through 62 °

Figure 39. Minimal clearance for tool-operated fasteners

3.3.7.11.3 Multiple fasteners.

When several fasteners are used on one item they shall be of identical type.

3.3.7.11.4 Captive fasteners.

All fasteners planned to be installed and/or removed on orbit shall be captive when disengaged.

3.3.7.11.5 Quick release fasteners.

a. Quick release fasteners shall require a maximum of one complete turn to operate (quarter-turn fasteners are preferred).
b. Quick release fasteners shall be positive locking in open and closed positions.

3.3.7.11.6 Theaded fasteners.

Only right-handed theads shall be used.

3.3.7.11.7 Over center latches.

a. Non-self-latching – Over center latches shall include a provision to prevent undesired latch element realignment, interface, or reengagement.
b. Latch lock – Latch catches shall have locking features.
c. Latch handles – If the latch has a handle, the latch handle and latch release shall be operable by one hand.

3.3.7.11.8 Winghead fasteners.

Winghead fasteners shall fold down and be retained flush with surfaces.

3.3.7.11.9 Fastener head type.

a. Hex type external or internal grip or combination head fasteners shall be used where on orbit crew actuation is planned, e.g., assembly replacement.
b. If a smooth surface is required, flush or oval head internal hex grip fasteners shall be used for fastening.
c. Slotted fasteners shall not be used to carry launch loads for hard-mounted equipment. Slotted fasteners are allowed in non-structural applications (e.g., computer data connectors, stowed commercial equipment).
   Note: Phillips or Torque-Set fasteners may be used where fastener installation is permanent relative to planned on orbit operations or maintenance, or where tool-fastener interface failure can be corrected by replacement of the unit containing the affected fastener with a spare unit.

3.3.7.11.10 One handed operation.

Fasteners planned to be removed or installed on orbit shall be designed and placed so they can be mated/demated using either hand.

3.3.7.11.11 Access holes.

Covers or shields though which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment (and hand or necessary tool if either is required to replace).

3.3.7.12 Controls and displays.

3.3.7.12.1 Controls spacing design requirements.

All spacing between controls and adjacent obstructions shall meet the minimum requirements as shown in Figure 40.

3.3.7.12.2 Accidental actuation.

3.3.7.12.2.1 Protective methods.

The CIR shall provide protection against accidental control actuation using one or more of the protective methods listed in subparagraphs a though g below. Infrequently used controls (i.e. those used for calibration) should be separated from frequently used controls. Leverlock switches or switch covers are strongly recommended for switches related to mission success. Switch guards may not be sufficient to prevent accidental actuation.

Note: Displays and controls used only for maintenance and adjustments, which could disrupt normal operations if activated, should be protected during normal operations, e.g., by being located separately or guarded/covered.

a. Locate and orient the controls so that the operator is not likely to strike or move them accidentally in the normal sequence of control movements.
b. Recess, shield, or otherwise surround the controls by physical barriers. The control shall be entirely contained within the envelope described by the recess or barrier.
c. Cover or guard the controls. Safety or lock wire shall not be used.
d. Cover guards when open shall not cover or obscure the protected control or adjacent controls.

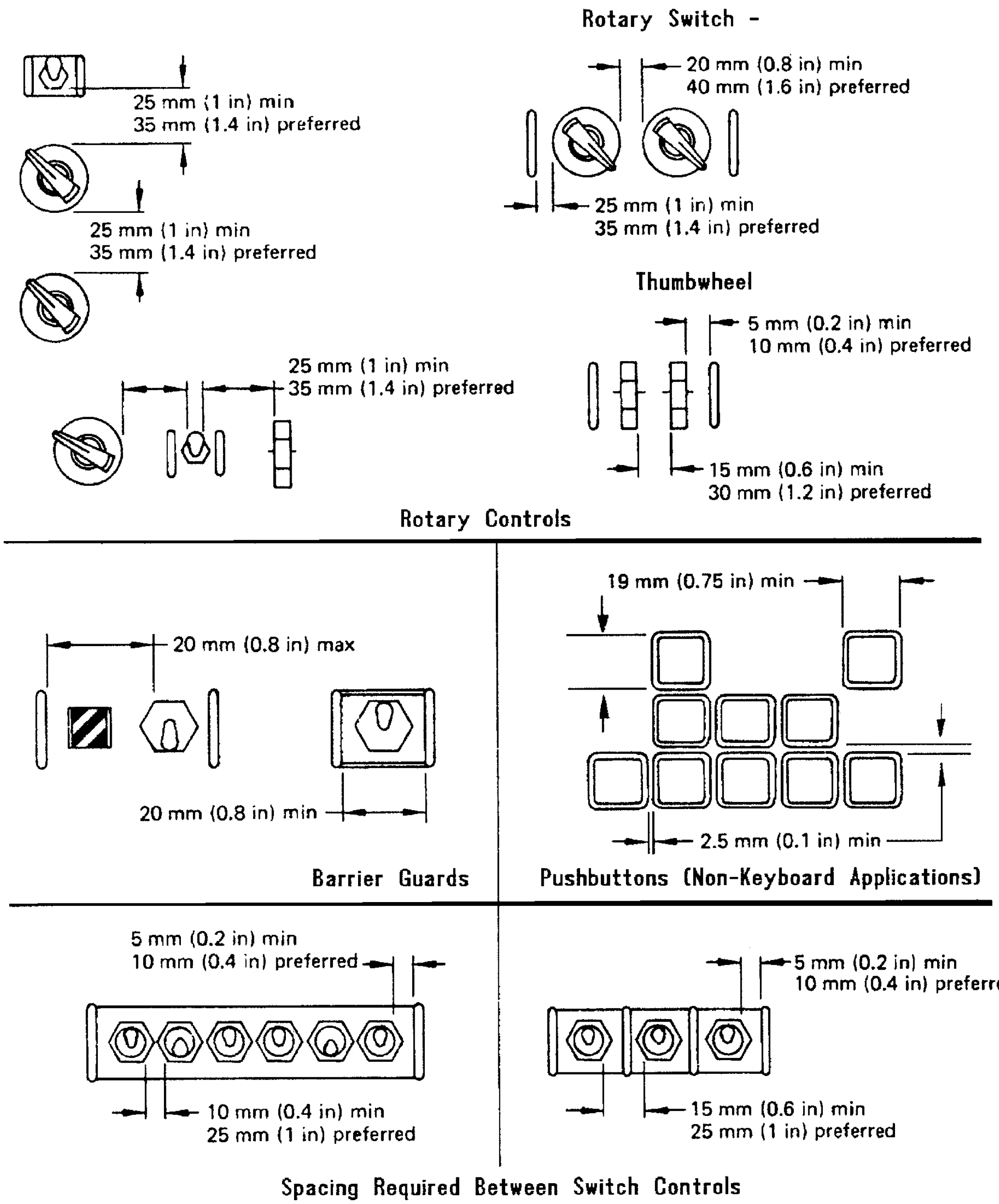


Figure 40. Control spacing requirements for ungloved operation

e. Provide the controls with interlocks so that extra movement (e.g., lifting switch out of a locked detent position) or the prior operation of a related or locking control is required.
f. Provide the controls with resistance (i.e., viscous or coulomb friction, spring-loading, or inertia) so that definite or sustained effort is required for actuation.
g. Provide the controls with a lock to prevent the control from passing though a position without delay when strict sequential actuation is necessary (i.e., the control moved only to the next position, then delayed).

3.3.7.12.2.2 Noninterference.

CIR provided protective devices shall not cover or obscure other displays or controls.

3.3.7.12.2.3 Dead-man controls.

Dead-man controls shall be as specified in NSTS 1700.7 ISS Addendum, paragraphs 200.4 a. and 303.2.

3.3.7.12.2.4 Barrier guards.

Barrier guard spacing shall adhere to the requirements for use with the toggle switches, rotary switches, and thumbwheels as shown in Figure 40 and Figure 41.

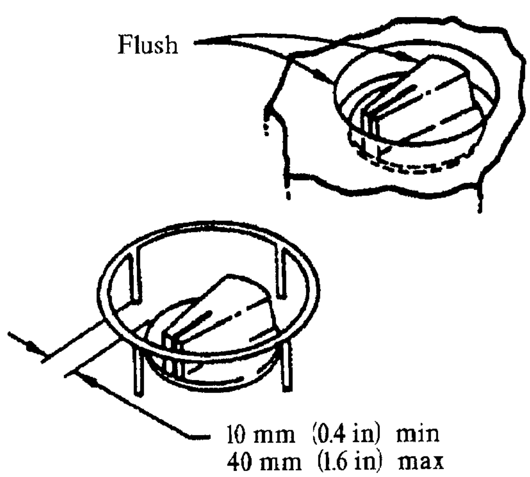


Figure 41. Rotary switch guard

3.3.7.12.2.5 Recessed switch protection.

When a barrier guard is not used, rotary switches that control critical functions shall be recessed as shown in Figure 41.

3.3.7.12.2.6 Position indication.

When CIR switch protective covers are used, control position shall be evident without requiring cover removal.

3.3.7.12.2.7 Hidden controls.

Controls that cannot be directly viewed will be avoided. If present, hidden controls shall be guarded to protect against inadvertent actuation.

3.3.7.12.2.8 Hand controllers.

Hand controllers, excluding trackballs and mice, shall have a separate on/off control to prevent inadvertent actuation when the controller is not in use.

3.3.7.13 Valve controls.

a. Low-Torque Valves – Valves requiring 1 N-m (10 in-lb) or less for operation are classified as "low-torque" valves and shall be provided with a "central pivot" type handle, 5.5 cm (2.25 in.) or less in diameter. (see 3.3.7.13 d.).
b. Intermediate-Torque Valves – Valves requiring between 1 and 2 N-m (10 and 20 in-lb) for operation are classified as "intermediate torque" valves and shall be provided with a "central pivot" type handle, 5.5 cm (2.25 in.) or greater in diameter, or a "lever type" handle, 7.5 cm (3 in.) or greater in length.
c. High-Torque Valves – Valves requiring 2 N-m (20 in-lb) or more for operation are classified as "high-torque" valves and shall be provided "lever type" handles greater than 7.5 cm (3 in.) or greater in length.
d. Handle Dimensions – Valve handles shall adhere to the clearances and dimensions illustrated in Figure 42 and Figure 43.
e. Rotary Valve Controls – Rotary valve controls shall open the valve with a counterclockwise motion.

3.3.7.14 Toggle switches.

Dimensions for a standard toggle switch shall conform to the values presented in Figure 44.

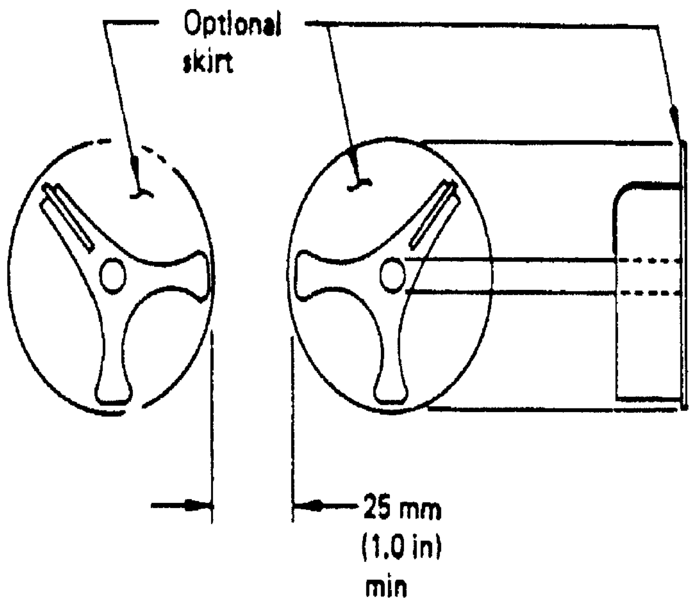


Figure 42. Valve handle – central pivot type

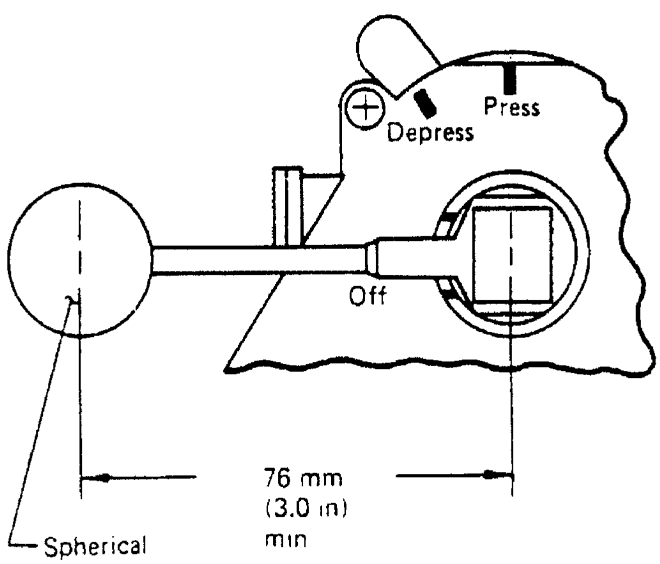
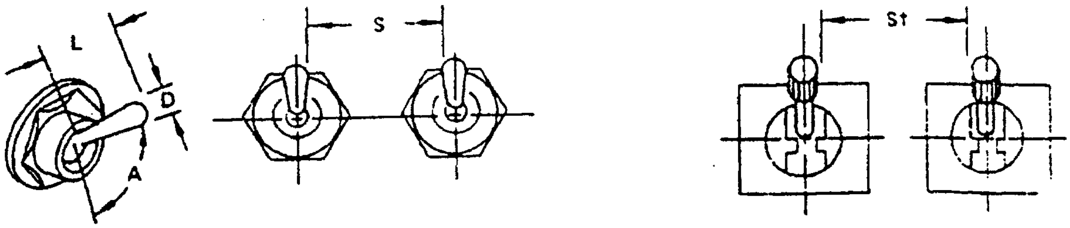


Figure 43. Valve handle – lever type



	Dimensions		Resistance	
	L Arm length	D Control tip	Small switch	Large switch
Minimum	13 mm (1/2 in)	3mm (1/8 in)	2.8 N (10 oz)	2.8 N (10 oz)
Maximum	50 mm (2 in)	25 mm (1 in)	4.5 N (16 oz)	11 N (40 oz)

	Displacement between positions A	
	2 position	3 position
Minimum	30°	17°
Maximum	80°	40°
Desired		25°

	Separation S			
	Single finger operation	†	Single finger sequential operation	Simultaneous operation by different fingers
Minimum	19 mm (3/4 in)	25 mm (1 in)	13 mm (1/2 in)	16 mm (5/8 in)
Optimum	50 mm (2 in)	50 mm (2 in)	25 mm (1 in)	19 mm (3/4 in)

† Using a lever lock toggle switch

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Reference: 2, page 93

Figure 44. Toggle switches

3.3.7.15 Restraints and mobility aids.

The CIR shall be designed such that all installation, operation, and maintenance can be performed using standard crew restraints, mobility aids, and interfaces as defined in SSP 30257:004.

3.3.7.16 Captive parts.

The CIR equipment shall be designed in such a manner to ensure that all unrestrained parts (e.g., locking pins, knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive.

3.3.7.17 Handle and grasp area design requirements.

3.3.7.17.1 Handles and restraints.

All removable or portable items which cannot be grasped with one hand shall be provided with handles or other suitable means of grasping, tethering, carrying, and restraining.

3.3.7.17.2 Handle location/front access.

Handles and grasp areas shall be placed on the accessible surface of a payload item consistent with the removal direction.

3.3.7.17.3 Handle dimensions.

IVA handles for movable or portable units shall be designed in accordance with the minimum applicable dimensions in Figure 45.

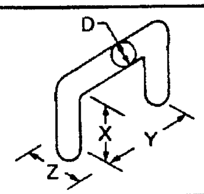
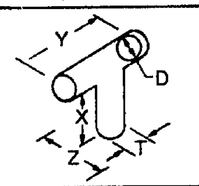
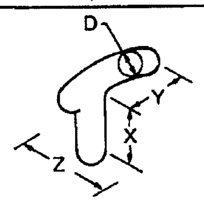
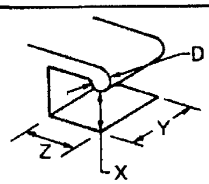
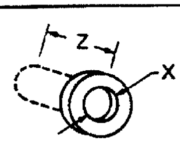
Illustration	Type of handle	Dimensions in mm (in inches) (Bare hand) X	Y	Z
	*Two-finger bar* One-hand bar Two-hand bar	32 (1–1/4) 48 (1–7/8) 48 (1–7/8)	65 (2–1/2) 111 (4–3/8) 215 (8–1/2)	75 (3) 75 (3) 75 (3)
	T-bar	38 (1–1/2)	100 (4)	75 (3)
	J-bar	50 (2)	100 (4)	75 (3)
	Two-finger recess One-hand recess	32 (1–1/4) 50 (2)	65 (2–1/2) 110 (4–1/4)	75 (3) 90 (3–1/2)
	Finger-tip recess One-finger recess	19 (3/4) 32 (1–1/4)	– –	13 (1/2) 50 (2)
Curvature of handle or edge (DOES NOT PRECLUDE USE OF OVAL HANDLES)	Weight of Item Up to 6.8 kg (up to 15 lbs) 6.8 to 9.0 kg (15 to 20 lbs) 9.0 to 18 kg (20 to 40 lbs) Over 18 kg (over 40 lbs) T-bar post	Minimum diameter D = 6 mm (1/4 in) D = 13 mm (1/2 in) D = 19 mm (3/4 in) D = 25 mm (1 in) T = 13 mm (1/2 in)	Gripping efficiency is best if finger can curl around handle or edge to any angle of 2/3 π rad (120°) or more	

Figure 45. Minimum IVA handle dimensions for IVA applications

3.3.7.17.4 Nonfixed handles design requirements.

a. Nonfixed handles shall have a stop position for holding the handle perpendicular to the surface on which it is mounted.

b. Nonfixed handles shall be capable of being placed in the use position by one hand and shall be capable of being removed or stowed with one hand.

c. Attachable/removable handles shall incorporate tactile and/or visual indication of locked/unlocked status.

3.3.8 Design requirements.

3.3.8.1 Units of measure.

The CIR shall use metric units as its primary unit of measure, except when interfacing with non-metric ISS equipment or lack of availability of metric components precludes it.

3.3.8.2 Margins of safety/factor of safety.

The design of the CIR shall use factors of safety as specified in NSTS 1700.7, NSTS 1700.7 ISS Addendum, and SSP 52005.

3.3.8.3 Allowable mechanical properties.

Values for mechanical properties of structural materials in their design environment shall be taken in accordance with MIL-HDBK-05 and MIL-HDBK-27 using the "A" allowable.

3.3.8.4 Fracture control.

The CIR structure shall meet the fracture control requirements as specified in NASA-STD-5003.

3.4 CIR computer resource requirements.

In addition to the computer resource requirements specified in paragraph 3.2, the CIR shall meet the requirements in this section.

3.4.1 CIR computer software design considerations.

a. The CIR primary processor shall be capable of self-activation and self-test once power is applied to the CIR power interface.
b. The CIR shall verify the integrity of all transmitted files.
c. A single computer within the CIR shall coordinate all automated activities performed by the CIR.

3.4.1.1 Command and data requirements.

3.4.1.1.1 Word/byte notations.

The CIR shall use the word/byte notations as specified in SSP 52050, paragraph 3.1.1.

3.4.1.1.2 Data types.

The CIR shall use the data types as specified in SSP 52050, paragraph 3.2.1 and subparagraphs.

3.4.1.1.3 Data transmissions.

a. The CIR data transmission on low rate data link (LRDL), MIL-STD-1553B shall use the data transmission order in accordance with D684-10056-01, paragraph 3.4.
b. The CIR data transmission on medium rate data link (MRDL) shall use the data transmission order in accordance with SSP 52050, paragraph 3.3.3.1.
c. The CIR data transmission on high rate data link (HDRL) shall use the data transmission order in accordance with CCSDS 701.0-B-2, paragraph 1.6.

3.4.1.1.4 Consultative committee for space data systems.

a. CIR data that is space to ground shall be Consultative Committee for Space Data Systems (CCSDS) data packets.
b. CIR data that is ground to space shall be CCSDS data packets.
c. CIR to Payload MDM data shall be CCSDS data packets.

3.4.1.1.4.1 CCSDS data packets.

CIR data packets shall be developed in accordance with SSP 52050, paragraph 3.1.3. CIR CCSDS data packets consist of a primary header and a secondary header followed by the data field.

3.4.1.1.4.1.1 CCSDS primary header.

CIR shall develop a CCSDS primary header in accordance with SSP 52050, paragraph 3.1.3.1.

3.4.1.1.4.1.2 CCSDS secondary header.

a. The CIR shall develop a CCSDS secondary header immediately following the CCSDS primary header.
b. The CCSDS secondary header shall be developed in accordance with SSP 52050, paragraph 3.1.3.2.

3.4.1.1.4.1.3 CCSDS data field.

The CIR CCSDS data field shall contain the CIR data from the transmitting application to the receiving application, and the CCSDS checksum in accordance with SSP 52050, paragraph 3.1 and subparagraphs.

3.4.1.1.4.1.4 CCSDS application process identification field.

The CCSDS application process identification (APID) shall be used for routing data packets as described in SSP 41175-2, paragraph 3.3.2.1.3. The format of APID is shown in SSP 41175-2, Table 3.3.2.1.1–1.

3.4.1.1.4.2 CCSDS time codes.

3.4.1.1.4.2.1 CCSDS unsegmented time.

CIR shall use CCSDS unsegmented time code (CUC) in the secondary header as specified in CCSDS 301.0-B-2, paragraph 2.2.

3.4.1.1.4.2.2 CCSDS segmented time.

Segmented time code shall be sent to the integrated rack by a broadcast message on the Payload MIL-STD-1553B. Segmented time code formats are specified in CCSDS 301.0-B-2, paragraph 2.4.

The broadcast time will be received at subaddress #29 on each Payload MIL-STD-1553B bus.

3.4.1.1.5 MIL-STD-1553B low rate data link (LRDL).

The CIR shall implement a single MIL-STD-1553B Remote Terminal (RT) to the payload unique MIL-STD-1553B bus in accordance with SSP 52050, paragraph 3.2.

3.4.1.1.5.1 Standard messages.

The CIR shall develop standard messages for the Payload MIL-STD-1553B in accordance with SSP 52050, paragraph 3.2.3.3.

3.4.1.1.5.2 Commanding.

The CIR shall receive and process commands from the Payload MDM that originate from the Ground, Timeliner, Payload MDM, and Portable Computer System (PCS) in accordance with SSP 52050, paragraph 3.2.3.4.

3.4.1.1.5.3 Health and status data.

a. The CIR shall develop health and status data in accordance with SSP 52050, paragraph 3.2.3.5.
b. The health and status data shall be documented in accordance with the data field format defined in SSP 57002, Table A–5. The definition of health and status data is provided in the Definitions, Appendix B of this document.
c. The CIR shall respond to its respective CIR MDM polls for health and status data with updated data at a 1 or 0.1 Hz rate.

3.4.1.1.5.4 Safety data.

a. Safety data shall be included in the health and safety data CCSDS packets provided by ISPR RT's.
b. The CIR shall provide as safety data the standard rack caution and warning status words in accordance with SSP 52050, paragraph 3.2.3.5.

3.4.1.1.5.5 Caution and warning.

3.4.1.1.5.5.1 Class 2 – warning.

The CIR shall format the caution and warning word in accordance with SSP 52050, paragraph 3.2.3.5 as a warning when the CIR sensors detect the following conditions:

1. A potential fire event, (detected by a sensor other than an ISS rack smoke detector or equivalent).
2. A precursor event that could manifest to an emergency condition (toxic atmosphere, rapid cabin depressurization or fire) and
   (a) Automatic safing has failed to safe the event or
   (b) The system is not automatically safed (i.e. requires manual intervention).
4. An event that results in the loss of a hazard control and
   (a) Automatic safing has failed to safe the event or
   (b) The system is not automatically safed (i.e. requires manual intervention).

Note: A warning requires someone to take action immediately. Warnings are used for events that require manual intervention and for notification when automatic safing fails.

3.4.1.1.5.5.2 Class 3 – caution.

The CIR shall format the caution and warning word in accordance with SSP 52050, paragraph 3.2.3.5 as a caution when the CIR sensors detect the following conditions:

1. A precursor event that could manifest to an emergency condition (toxic atmosphere, rapid cabin depressurization, or fire) and automatic safing has safed the event (i.e. the system does not require manual intervention).
2. An event that results in the loss of a hazard control and automatic safing has safed the event (i.e., the system does not require manual intervention).

Note: A caution requires no immediate action by the crew. Automatic safing has controlled the event.

3.4.1.1.5.5.3 Class 4 – advisory.

The CIR shall format the caution and warning word in accordance with SSP 52050, paragraph 3.2.3.5as an advisory. Advisories are set for the following conditions:

1. Advisories are set primarily for ground monitoring purposes (advantageous due to limited comm. coverage and data recording).
2. Data item that most likely will not exist permanently in Telemetry List but should be time tagged and logged for failure isolation, trending, sustaining engineering, etc.

3.4.1.1.5.6 Service requests.

The CIR shall develop service requests that shall be in accordance with SSP 52050, paragraph 3.2.3.7. The service requests data format shall be developed in accordance with SSP 52050, Table 3.2.3.7–1.

3.4.1.1.5.7 File transfer.

The CIR shall develop its file transfer in accordance with SSP 52050, paragraph 3.2.3.9.

3.4.1.1.5.8 Low rate telemetry.

The CIR shall develop low rate telemetry (i.e. science data) in accordance with SSP 52050, paragraph 3.2.3.10.

3.4.1.1.5.9 Defined mode codes.

CIR MIL-STD-1553B shall use the mode codes as specified in SSP 52050, paragraph 3.2.3.2.1.5.

3.4.1.1.5.10 Implemented mode codes.

The CIR MIL-STD-1553B Remote Terminal (RT) may be designed to recognize both unimplemented and undefined mode codes as illegal commands. If the RT designer does decide to monitor for unimplemented/undefined code modes, the RT shall respond by setting the message error bit in the status word.

3.4.1.1.5.11 Illegal commands.

The CIR MIL-STD-1553B RT's are not required to respond to illegal commands. If an RT designed with this option detects an illegal command, it shall respond to the illegal command by setting the message error bit in the status word.

3.4.1.1.5.12 LRDL interface characteristics.

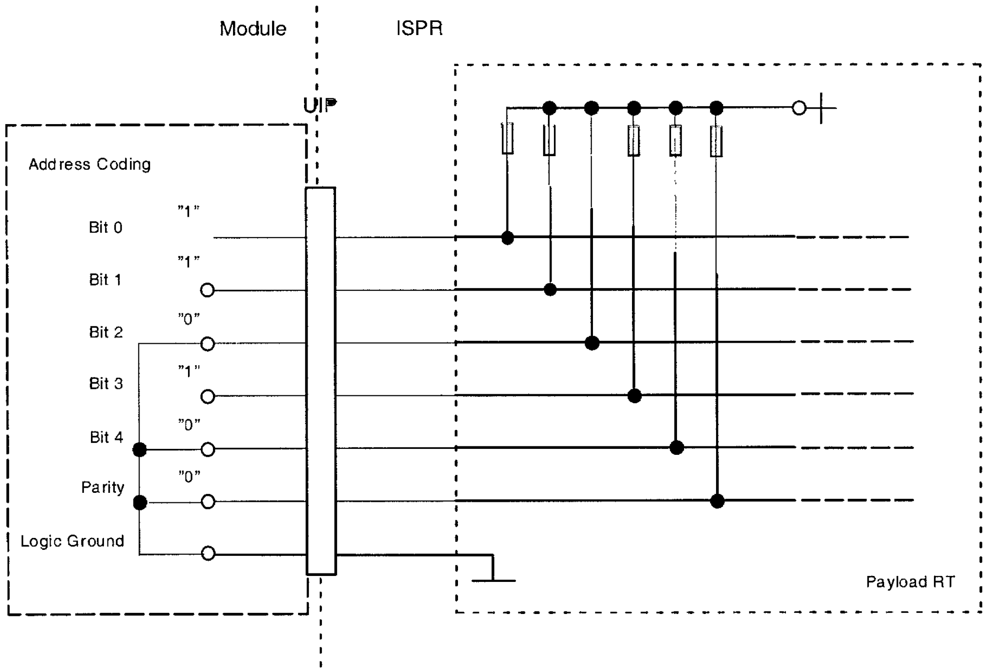
a. CIR connectors P3 and P4 shall meet the pinout interfaces of the UIP J3 and J4 connectors respectively as specified in SSP 57001, paragraph 3.3.2.2.
b. CIR connectors P3 and P4 shall meet the requirements of SSQ 21635 or equivalent.

3.4.1.1.5.12.1 Remote terminal hardwired address coding.

a. The CIR shall be designed to read and respond to the hardware Remote Terminal address coding scheme for the Standard Payload Bus, for all ISPR locations defined in Table XXIV. Details of the implementation of the payload Remote Terminals are illustrated in Figure 46.
b. Decimal values shall be mapped in 5 bit presentation, bit 0 = Least Significant Bit (LSB), see Figure 46.
c. Odd-parity shall be used.
d. Jumpering address line to ground shall be logic 0.
e. Pull up devices, shown in Figure 46, shall be in accordance with MIL-STD-1553B.

Table XXIV. Remote terminal hardwired address coding for standard payload bus

APM ISPR		JEM ISPR		USL ISPR		CAM ISPR	
Location	RT Hardwired Address	Location	RT Hardwired Address	Location	RT Hardwired Address	Location	RT Hardwired Address
APM1F1	15	JPM1F1	15	LAB101	8	CAM1F2 (TBC)	20
APM1F2	16	JPM1F2	16	LAB102	9	CAM1F3 (TBC)	21
APM1F3	17	JPM1F3	17	LAB103	10	CAM1A2 (TBC)	20
APM1F4	18	JPM1F5	18	LAB104	11	CAM1A3 (TBC)	21
APM1A1	19	JPM1F6	19	LAB105	12	CAM1A3 (TBC)	**(TBD #9)**
APM1A2	20	JPM1A1	20	LAB1S1	8		
APM1A3	21	JPM1A2	21	LAB1S2	9		
APM1A4	22	JPM1A3	22	LAB1S3	10		
APM101	23	JPM1A4	23	LAB1S4	11		
APM102	24	JPM1A5	24	LAB1D3	14		
				LAB1P1	12		
				LAB1P2	15		
				LAB1P4	17		



Note: Example RT Address = 11 in decimal representation.
All address and parity lines have pull up resistors so that "0" on those lines is achieved by connecting the lines to common secondary return. The parity is odd. Bit 0 is LSB.

Figure 46. Remote terminal hardwired address coding example

3.4.1.1.5.12.2 LRDL signal characteristics.

a. The CIR shall meet the electrical characteristics in accordance with MIL-STD-1553B.
b. The CIR MIL-STD-1553B terminal characteristics shall be in accordance with MIL-STD-1553B, paragraph 4.5.2.

3.4.1.1.5.12.3 LRDL cabling.

a. The CIR MIL-STD-1553B internal wiring characteristics shall be according to SSQ 21655 for 75 Ω or equivalent.
b. The CIR MIL-STD-1553B internal wiring characteristics are summarized in MIL-STD-1553B, Table 3.3.5.2.3–1.
c. The CIR MIL-STD-1553B internal wiring stub length shall not exceed 12 ft (3.65 m) when measured from the internal MIL-STD-1553B Remote Terminal to the ISPR Utility Interface Panel.

Table XXV. MIL-STD-1553B network characteristics

Characteristic	Parameter
Type	Twisted Shielded Pair SSQ 21655 or Equivalent
Characteristic Impedance	75 ± 5 Ohm
Cable Size	22 AWG or 24 AWG
Nominal wire-to-wire Capacitance	66 pf/m

3.4.1.1.5.12.4 Multi-bus isolation.

The signal isolation between multiple ISS Payload MIL-STD-1553B data buses shall be no less than 58 dB.

3.4.1.1.6 Medium rate data link (MRDL).

3.4.1.1.6.1 MRDL protocol.

The CIR shall conform with ISO/IEC 8802-3 10-Base-T protocol in accordance with SSP 52050, paragraph 3.3.

3.4.1.1.6.2 CIR protocols on the MRDL.

a. The CIR shall conform with ISO/IEC 8802-3 10-Base-T protocol in accordance with SSP 52050, paragraph 3.3.
b. The CIR shall use the CCSDS protocol and gateway protocol in SSP 52050, paragraphs 3.3.4 and 3.3.7.

3.4.1.1.6.3 MRDL address.

a. The CIR shall have a unique Institute of Electrical and Electronic Engineers (IEEE) issued physical address.
b. The unique address shall be set prior to the Ethernet terminal going active. The CIR will indicate the unique physical address in the SSP 57217.

3.4.1.1.6.4 CIR MRDL connectivity.

a. The CIR with an MRDL connection shall have no more than one physical connection per LAN. An integrated rack with an MRDL connection may have one physical connection to LAN-1 and one physical connection to LAN-2. LAN-1 is located in J46 and LAN-2 is located in J47.
b. The CIR shall not route or transmit the same MRDL message to the ISS LAN’s simultaneously.

c. The CIR with internal MRDL(s) shall provide isolation between the ISS MRDL LAN's and the internal LAN's with either an Ethernet Bridge or an Internet Protocol router that connects the LAN-1 and LAN-2 to the internal rack LAN(s).
d. The Ethernet device connected to the ISS LAN shall have a (unique) IEEE issued address.

3.4.1.1.6.5 MRDL connector/pin assignments and wire requirements.

a. The CIR connectors P46 and P47 shall meet the pinout interfaces of the UIP J46 and J47 connectors as specified in SSP 57001, paragraph 3.3.3.1.
b. CIR LAN-1 and LAN-2 connectors P46 and P47 shall meet the requirements of SSQ 21635 or equivalent.
c. CIR LAN-1 and LAN-2 wires shall meet the requirements of 100 Ω twisted-pair per SSQ 21655 or equivalent. The 100 Ω twisted shielded pair cable defined in SSQ 21655 must be used due to its characteristics at MRDL data transmission frequencies.

3.4.1.1.6.6 MRDL signal characteristics.

The CIR shall meet the electrical characteristics of MRDL in accordance with ISO/IEC 8802-3 with the following exceptions:

IEC Publication	60	High-Voltage Test Techniques
IEC Publication	380	Safety of Electrically Energized Office Machines
IEC Publication	435	Safety of Data Processing Equipment
IEC Publication	950	Safety of Information Technology Equipment, Including Electrical Business Equipment

3.4.1.1.6.7 MRDL cable characteristics.

The MDRL cable characteristics shall be as given in Table XXVI.

Table XXVI. Link segment cable characteristics

Characteristic	Parameter
Characteristic Impedance	100 ±7 Ohm
Cable Size	22 AWG
Type of Cable	Twisted Shielded Pair SSQ 21655 or Equivalent
Nominal wire-to-wire Capacitance	45 pF/m
Max Cable Length in ISPR	5 m

3.4.1.1.6.7.1 Differential characteristic impedance.

The ISPR differential characteristic impedance shall meet the requirements specified in ISO/IEC 8802-3, paragraph 14.4.2.2 with the exception that the wire meets the performance characteristics in Table XXVII.

Table XXVII. NTSC video performance characteristics.

Characteristic	End-to-End Path Characteristics	Test Method
Amplitude vs. Frequency	10 KHz to 300 KHz: ±0.2 dB at 3.58 Mhz ± 300 Khz :±0.4 dB to 4.2 Mhz: ±0.7 dB (A) to 10 Mhz: +1/–3 dB	EIA/TIA – 250C Para 6.1.1
Chrominance to Luminance Gain Inequality	± 4.0 IRE units	EIA/TIA – 250C Para 6.1.2.1
Chrominance to Luminance Delay Inequality	± 26 ns	EIA/TIA – 250C Para 6.1.2.2
Field Time Waveform Distortion	3 IRE units peak-to-peak	EIA/TIA – 250C Para 6.1.4
Line Time Waveform Distortion	1 IRE unit peak-to-peak	EIA/TIA – 250C Para 6.1.5
Short Time Waveform Distortion	2.0%	EIA/TIA – 250C Para 6.1.1
Long Time Waveform Distortion	8 IRE units overshoot Max. setting to 5 IRE units after 3 Sec.	EIA/TIA – 250C Para 6.1.7
Line-By-Line DC Offset	± 2.0 IRE Max.	
Insertion Gain and Variation	± 0.2 dB	EIA/TIA – 250C Para 6.1.8
Luminance Non-Linearity	6% Max	EIA/TIA – 250C Para 6.2.1
Differential Gain	4% Max	EIA/TIA – 250C Para 6.2.2.1
Differential Phase	1.9 degrees	EIA/TIA – 250C Para 6.2.2.2
Chrominance to Luminance Intermodulation	2.0 IRE	EIA/TIA – 250C Para 6.2.3
Chrominance Non-Linear Gain	2.0 IRE	EIA/TIA – 250C Para 6.2.4.1
Chrominance Non-Linear Phase	2.0 degrees	EIA/TIA – 250C Para 6.2.4.2
Dynamic Gain of the Picture Signal	4.0 IRE	EIA/TIA – 250C Para 6.2.5.1
Dynamic Gain of the Synchronizing Signal	2.0 IRE	EIA/TIA – 250C Para 6.2.5.2
Transient Synchronizing Signal Non-Linearity	3.0 IRE	EIA/TIA – 250C Para 6.2.6
Signal to Noise Ratio (10 KHz to 5 MHz) (Triangular)	43.8 dB min, unweighted	EIA/TIA – 250C Para 6.3.1
Signal to Noise Ratio (10 KHz to 10 MHz) (Triangular)	36.6 dB min, unweighted	EIA/TIA – 250C Para 6.3.1
Signal to Low Frequency Noise (0–10 kHz)	50 dB min, unweighted	EIA/TIA – 250C Para 6.3.2
Signal to Periodic Noise Ratio (300 Hz to 4.2 MHz)	63 dB min, unweighted	EIA/TIA – 250C Para 6.3.3
2T Short Time Distortion	± 4.0 IRE units	NTC–7 Para 3.5
Group Delay (5 to 10 MHz)	150 ns	

Note

(A) Monotonic roll off beyond 4.2 Min MHz.

3.4.1.1.7 CIR to high-rate frame multiplexer (HFM) protocols.

The CIR shall use the HFM common protocols in accordance with SSP 50184, paragraph 3.3.2.

3.4.1.1.7.1 High rate data link (HDRL) physical signaling data rates.

a. The CIR shall be designed to transmit data on the HDRL with adjustable data rates in between 0.5 and 95 Mbps.
b. The CIR HDRL data rate shall be adjustable in increments of 0.5 Mbps.
c. Transmitted data shall be designed to be “evenly parsed” in accordance with SSP 50184, paragraph 3.3.1.3.2.

Note:

1. The HDRL is a shared resource on the ISS. The HDRL data is sent to the ground though the HFM. When a payload has the entire HFM capacity assigned to that payload, the Maximum HDRL data rate is approximately 43 Mbps. Under normal conditions the payload shares the 43 Mbps with 11 other data sources. The actual HDRL data rate designed into the payload is subject to planning.
2. The CIR maximum designed data rate is subject to planning.
3. The CIR is not required to implement every possible increment in the negotiated range. For example, an integrated rack may choose to implement 0.5, 1.0, 2.0, 4.0, 8.0, and 16.0 Mbps for a planned range of 0.5 to 16.0 Mbps.
4. The data rate tolerance is under investigation.
5. The CIR may use any HDRL data rate desired in a multi-location payload where the source payload and the destination payload for the HDRL data is developed by one payload project.

3.4.1.1.7.2 Encoding.

The CIR shall encode the HDRL data in accordance with SSP 50184, paragraph 3.1.3; SSP 50184, paragraph 3.1.3.1; SSP 50184, Table 3.1.3.1–1; and SSP 50184, paragraph 3.1.3.2.

3.4.1.1.7.3 Symbols used in testing.

The CIR shall provide the Halt symbol (H) in accordance with SSP 50184, Table 3.1.3.1–1for use in optical power tests.

3.4.1.1.7.4 CIR HDRL transmitted optical power.

a. The CIR shall be designed to transmit a HDRL signal in accordance with SSP 50184, paragraph 3.1.1 at an average optical power greater than -16.75 dBm and less than -8.3 dBm.
b. The CIR transmitted optical power shall be measured at the CIR P7 connector to the ISPR connector interface panel using the Halt symbol.

3.4.1.1.7.5 HDRL fiber optic cable.

The CIR shall use fiber optic cable in accordance with SSQ 21654.

3.4.1.1.7.6 HDRL fiber optic bend radius.

The CIR shall develop the routing, installation, and handling procedures to assure the minimum bend radius of 2 in. or greater is maintained at all times for the fiber optic cable.

3.4.1.1.7.7 HDRL connectors and fiber.

a. The CIR connector P7 shall meet the pinout interfaces of the UIP J7 connector as specified in SSP 57001, paragraph 3.3.4.1.
b. The CIR HDRL connector P7 shall meet the requirements of SSQ 21635 or equivalent.
c. The CIR HDRL fiber shall meet the requirements of SSQ 21654 or equivalent.

3.4.1.1.8 Station support computer (SSC).

a. The CIR shall be limited to one shared SSC. The SSC is not dedicated to a rack; memory and hard drive availability for payload displays and software must be negotiated with the Payload Software Control Panel.
b. SSC displays shall be in accordance with SSP 50313 (not unique to SSC).

3.4.1.1.9 CIR national television systems committee (NTSC) video and audio interface requirements.

3.4.1.1.9.1 CIR NTSC video characteristics.

a. CIR NTSC video characteristics shall be in accordance with Table XXVII.
b. The interpretation shall be in accordance with EIA/TIA RS-250-C End to End NTSC Video for Satellite Transmission System.
c. Video signal to crosstalk noise shall be in accordance with NTC-7, paragraph 3.19.

3.4.1.1.9.2 Pulse frequency modulation NTSC fiber optic video characteristics.

a. The pulsed frequency modulation (PFM) fiber optic video shall be in accordance with paragraph 3.4.1.1.9.1.
b. The PFM fiber optic characteristics shall be in accordance with Table XXVIII.

Notes:

1. Or any video/data format compatible with PFM characteristics as indicated in Table XXVIII.
2. With the emphasis enabled the above setup results in PFM frequencies of 53.27 MHz for the white level (100 Institute of Radio Engineers (IRE)/714 mV), 48.57 MHz for the blanking level (0 IRE/0 mv), and 46.67 MHz for sync tip (-40 IRE/-286 mV).

Table XXVIII. NSTS fiber optic video signal characteristics.

PFM Signal Bandwidth	40–72 Megahertz (MHz)
PFM Signal Characteristics	Square wave, FM signal characterized by nominal 50 percent duty cycle
PFM Center Frequency (Blanking Level)	48.57 MHz (0 IRE/0mV)
White Level Frequency	70.25 Mhz (100 IRE/714 mV)
Sync Tip Frequency	40.07 Mhz (–40 IRE/–286 mV)
Blanking Level Variation	+/– 2 Mhz
Video Signal Format	NTSC composite NTSC/EIA–RSA–170A (1)
Pre-emphasis/De-emphasis	per CCIR Recommendation 405 of EIA/TIA–250–C. (1) (2)
Bus Media	Fiber Optics on both SSMB and APM sides
Video Sync	EIA–RS–170A Compliant Black Burst Sync

Notes:

(1) Or any video/data format compatible with PFM characteristics as indicated in this Table.

(2) With the emphasis enabled the above set-up results in PFM frequencies of 53.27 MHz for the white level (100 IRE/714 mV), 48.57 MHz for the blanking level (0 IRE/0mv), and 46.67 MHz for sync tip (–40 IRE/–286 mV).

3.4.1.1.9.3 CIR NTSC PFM video transmitted optical power.

The CIR shall be designed to transmit a video PFM signal at an average optical power greater than -15.5 dBm.

3.4.1.1.9.4 Fiber optic cable characteristics.

The video/data and sync signals shall use fiber optic cable in accordance with Table XXIX.

Table XXIX. PFM NTSC video optical fiber characteristics.

Parameter	Dim.	Medium Characteristics
Operating Wave length (min/max)	nm	1270/1380
Fibre Type	–	graded index, multimode
Fibre Core Diameter (min/max)	μm	98/102
Fibre Cladding Diameter (min/max)	μm	138/142
Numerical Aperture (min/max)	–	0.28/0.32
Attenuation @ 1290± 10nm	dB/Km	≤ 4
Modal Bandwidth @ 1290± 10nm	MHz × Km	200
–Signal Timing:		
Optical Rise Time (10% to 90%)	ns	≤ 3.5
Optical Fall Time (10% to 90%)	ns	≤ 3.5
Random Jitter (peak to peak) (1)	ns	≤ 0.76
Data Dependent Jitter (peak to peak) (1)	ns	≤ 0.6
Duty Cycle Distortion (peak to peak) (1)	ns	≤ 1

Note:

(1) These parameter refer to fibre optic data test setup.

3.4.1.1.9.5 PFM NSTC video fiber optic cable bend radius.

The CIR shall develop the routing, installation, and handling procedures to assure the minimum bend radius of 2 in. or greater is maintained at all times for the fiber optic cable.

3.4.2 Flexibility and expansion.

a. The CIR software shall be modifiable via the ISS communication network.
b. CIR software shall be modularized separate from PI-specific hardware.
c. CIR software shall be written in C++ and/or Java programming languages with the exception of COTS software and software classified as time critical.
d. After deployment of the SAR, the CIR shall have the capability to transfer internal bus controller (Master) functions from the primary processor to at least one other processor.
e. Prior to SAR deployment, each computer communication bus (1553, Ethernet, etc.) shall be designed such that the transfer of all data from the basis experiments, as specified in FCF-DOC-002, and all associated CIR health data does not exceed 55% of bus bandwidth over any 10 s period.
f. After SAR deployment, each computer communication bus (1553, Ethernet, etc.) shall be designed such that all the transfer rates of all data from the basis experiments, as specified in FCF-DOC-002, and all associated CIR health data does not exceed 60% of the bus bandwidth over any 10 s period.
g. Prior to the deployment of the SAR, during all planned operational modes, all single board computers and associated circuit boards in the FIR and the CIR shall be designed to have their volatile memory (e.g., RAM) sized such that the basic software functions required to

perform the basis experiments and collect generated data as specified in FCF-DOC-002 do not utilize more than 55 % of the bytes available for the particular volatile memory.

h. After SAR deployment, during all planned operational modes, all single board computers and associated circuit boards in the CIR shall be designed to have their volatile memory (e.g., RAM) sized such that the basic software functions required to perform the basis experiments and collect all generated data as specified in FCF-DOC-002 do not utilize more than 65 % of the bytes available for the particular volatile memory.
i. Prior to the deployment of the SAR, during all planned operational modes, all single board computers and associated circuit boards in the FIR and the CIR shall be designed to have their non-volatile memory sized such that the basic software functions required to perform the basis experiments and collect generated data as specified in FCF-DOC-002 do not utilize more than 50 % of the bytes available for the particular non-volatile memory.
j. After SAR deployment, during all planned operational modes, all single board computers and associated circuit boards in the CIR shall be designed to have their non-volatile memory sized such that the basic software functions required to perform the basis experiments and collect all generated data as specified in FCF-DOC-002 do not utilize no more than 80 % of the bytes available for the particular non-volatile memory.
k. Prior to the deployment of the SAR, during all planned operational modes, all mass storage in the FIR and the CIR shall be sized such that the space required to store all data does not exceed 50 % of the bytes available and 70 % of the data read/write rates available as specified in the basis experiments in FCF-DOC-002 for the particular mass storage. To meet this requirement it shall be assumed that no data can be offloaded from the mass storage during the conduct of the experiment (i.e., all information generated and sent to the mass storage must be retained).
l. After SAR deployment, during all planned operational modes, all mass storage in the CIR shall be sized such that the space required to store all data does not exceed 80 % of the bytes available or 70 % of the data read/write rates available as specified in the basis experiments in FCF-DOC-002 for the particular mass storage. To meet this requirement it shall be assumed that no data can be offloaded from the mass storage during the conduct of the experiment (i.e., all information generated and sent to the mass storage must be retained).

3.4.3 Software portability.

a. The CIR software shall be designed to facilitate migration for programs from systems supporting CIR development.
b. CIR software shall be designed to facilitate migration of programs to upgraded hardware and firmware.

3.4.4 Data date/time stamps.

a. All data shall be date/time stamped as specified in paragraph 3.2.1.35 by the primary computer collecting the data.

b. Data flowing from one computer to another where date/time stamps have been applied shall not have their date/time stamps overwritten.

3.5 Logistics.

3.5.1 Maintenance.

The CIR shall be designed to allow for changeout, maintenance, and upgrade of hardware and software to conduct the basis experiments as specified in FCF-DOC-002.

3.5.2 Supply.

The CIR shall be designed to perform a minimum of 5 basis-type experiments per year as specified in FCF-DOC-002 using no more than the up-mass and stowage volume resupply requirements as specified in paragraph 3.2.2.

3.5.3 Facilities and facility equipment.

Facilities and facility equipment are described in FCF-SPC-0005.

3.6 Personnel and training.

3.6.1 Personnel.

a. The CIR shall be designed to be nominally maintained and operated by one crew member.
b. The CIR shall be designed to be operated using ground commands once experiment setup is completed by the crew.
c. The CIR shall be designed such that no more than two crew members are required for off-nominal and troubleshooting operations.

3.6.2 Training.

The CIR shall be designed for simple and logical installation, maintenance, and operation to minimize crew training. Details concerning training are provided in FCF-DOC-0005.

3.7 Major component characteristics.

The CIR assemblies listed in paragraphs 3.1.6 and 3.1.9 have their individual product specification which lists their specific requirements. Certain assemblies shall meet the additional requirements listed in the following paragraphs.

3.7.1 Water Thermal Control System (WTCS).

a. Coolant contained in the WTCS that interfaces with ISS US Lab ITCS coolant shall satisfy the cleanliness and materials requirements specified below:
    1. The WTCS shall use fluids that meet the requirements specified in SSP 30573.
    2. The WTCS shall meet the fluid system cleanliness levels specified in SSP 30573.

The WTCS shall use internal materials that are compatible according to MSFC-SPEC-250, Table III or that will not create a potential greater than 0.25 V with the ISS system internal materials due to a dissimilar metal couple.

b. The WTCS shall be delivered on orbit and during transport charged with coolant as specified in paragraph 3.7.1 a. Integrated racks that are not actively serviced by the MPLM Thermal Control System during transport shall be charged to allow for thermal expansion between the temperatures of 1.67 and 46°C (35 and 114.8°F).
c. The WTCS shall be designed to meet the US Lab moderate temperature loop pressure drop specified in Figure 47 with both halves of each mated quick disconnect (QD) pair included as part of the payload pressure differential.
d. The WTCS shall be designed to meet the US Lab moderate temperature loop allowable flow rate: ITCS Selectable Coolant Flow Rate = 100 - 745 lbm/h (45 - 339 kg/h).
e. The WTCS shall be designed to meet the US Lab moderate temperature loop coolant supply temperature: ITCS Coolant Supply Temperature = 61 - 65 ^{o}F (16 - 18.3 ^{o}C).
f.
    1. The WTCS using moderate temperature coolant at operating modes above 1025 W shall have a minimum differential temperature across the integrated rack (inlet to outlet) of 19.5°C (35°F).
    2. The WTCS using moderate temperature coolant shall be designed to operate using 100 lbm/h flow during operating modes which require less than 1025 W of power.
    3. The maximum moderate temperature coolant return temperature shall be no greater than 49°C (120°F).
g. The WTCS shall withstand the moderate temperature loop maximum design pressure of 121 psia (834 kPa).
h. The WTCS shall assess the payload equipment and rack internal water loop piping to ensure that it is fail safe in the case of loss of cooling under all modes of operation.
i. The WTCS shall not exceed the maximum rack leakage rate of water of 14x10 -3 scc/ h (liquid) per each thermal loop at the MDP of 121 psia (834 kPa).
j. WTCS QD's shall not exceed the maximum air inclusion of .30 cc maximum per mate or demate operation.
k. The WTCS automated flow control systems shall be designed such that set point changes resulting in flow rate changes greater than 5 lbm/h shall take at least 100 s to reach 63.2% (i.e., $1 - e^{-1}$) of the commanded change in flow rate.
l. The WTCS shall contain no more than the maximum allowable coolant quantity of water, referenced at 61°C (141.8°F). The maximum allowable coolant quantity of water in the US Lab MTL is 42.25 gal. (159.9 L).
Note: Payload racks are to have a design target for total rack coolant volume of no more than 1.82 gal (6.90 L) on the MTL.
m. The WTCS shall not exceed the maximum allowable gas inclusion or volume at the maximum design pressure into the US Lab Internal Thermal Control System of 8.88 in^3 (0.146 L).
n. The WTCS shall meet the physical and functional interfaces depicted in Figure 1 of the FSS Interface Definition Drawing (IDD), 683-17103.

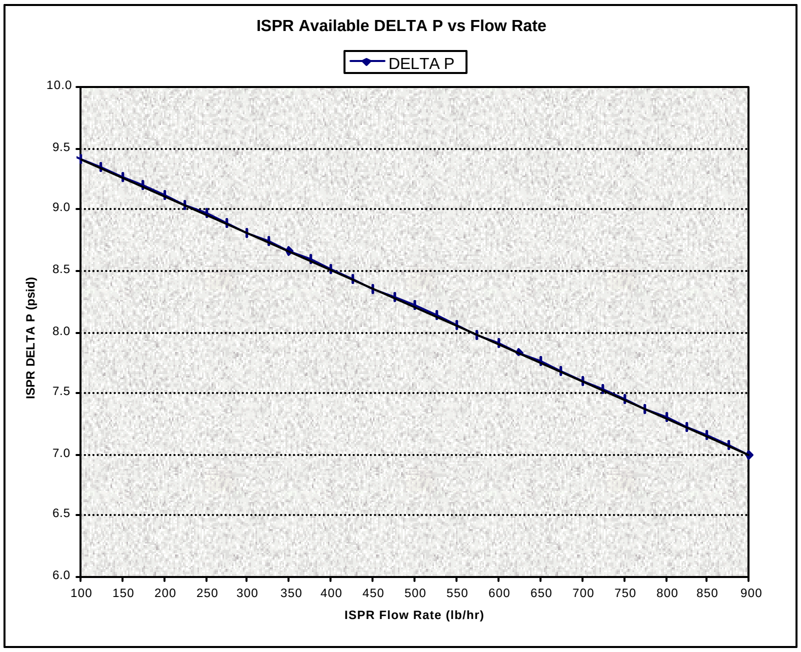


Figure 47. U.S.Lab MTL available pressure drop vs. flow rate

3.7.2 Vacuum exhaust system/waste gas system(VES/WGS) requirements.

a. The CIR shall limit its vented exhaust gas to a pressure of 276 kPa (40 psia) or less at the rack to ISS interface.
b. The CIR volume connected to the VES/WGS shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005, paragraph 5.1.3.
c. The CIR shall be two failure tolerant to protect against failure conditions which would exceed VES/WGS max design pressure of 40 psia.
d. The initial temperature range of exhaust gases shall be between 16 and 45°C (60 and 113°F).
e. The initial dewpoint of exhaust gases shall be limited to 16°C (60°F) or less.
f. The CIR exhaust gases vented into the VES/WGS of the US Lab shall be compatible with the wetted surface materials of the respective laboratory(ies) in which the integrated rack will operate, as defined in SSP 41002, paragraph 3.3.7.2. (See Appendix H for exceptions to this requirement.)
g. The CIR shall be nonreactive with other vent gas mixture constituents.
h. The CIR shall provide a means of removing gases that would adhere to the ISS VES/WGS tubing walls at a wall temperature of 4°C (40°F) and at a pressure of 10 (-3) torr.
i. The CIR shall remove particulates from vent gases that are larger than 100 µm in size.
j. Gases venting from the CIR shall be in accordance with the list of acceptable exhaust gases with verified compatibility to the USL VES wetted materials as specified in SSP 57000 Appendix D1 and the list of unacceptable gases that are not compatible with the USL VES as specified in Appendix D2.
k. Exhaust gases shall be compatible with paragraph 3.4 of SSP 30426 for molecular column density, particulates, and deposition on external ISS surfaces.
l. The CIR shall provide containment, storage, and transport hardware for gases that are incompatible with the vacuum exhaust or external environment.

m. Containment hardware for incompatible exhaust gases shall meet the redundant container requirements specified in NSTS 1700.7 ISS Addendum, paragraph 209.1 b.

3.7.3 ISS nitrogen usage requirements.

a. The CIR shall provide a means, located within the integrated rack envelope, to turn on and off the flow of nitrogen to the integrated rack and to control the flow of nitrogen to not exceed 5.43 kg/h (12 lbm/h) when connected to the nitrogen interface operating pressure range of 517 to 827 kPa (75 to 120 psia).
b. The MDP of the CIR interfacing with the nitrogen system shall be 1,379 kPa (200 psia).
c. The CIR nitrogen system shall be designed for a nitrogen supply temperature range of 15.6 to 45°C (60 to 113°F).
d. The CIR shall have a nitrogen leakage rate no greater than 10^{-3} scc/s.

3.8 Precedence.

All specifications, standards, exhibits, drawings, or other documents that are referenced in this specification are hereby incorporated as cited, with the exception of those documents specifically cited to be used for reference only.

4.0 QUALITY ASSURANCE

Verification of the CIR shall be performed as specified in this section. Verifications shall show compliance with each "shall" statement in sections 3.0 and 5.0. Non "shall" statements are not required to be verified for compliance.

4.1 General.

The primary location for CIR verification will be at the contractor test facility or at locations contracted to perform verifications by the contractor. Data and reports generated as part of the verification process will be retained for the life of the CIR. The CIR verification will be conducted though inspection, analysis, demonstration, and test.

The following verification methods are defined and shall be used to qualify the system:

1. Inspection - Verification by visual examination of the item, or reviewing descriptive documentation, and comparing the appropriate characteristics with predetermined standards to determine conformance to requirements without the use of special laboratory equipment or procedures.
2. Analysis - Verification by technical or mathematical models or simulation, algorithms, charts, graphs, or circuit diagrams, and representative data.
3. Demonstration - Verification by operation, adjustment or reconfiguration of items performing their designed functions under specific scenarios. The items may be instrumented and quantitative limits or performance monitored, but only check sheets rather than actual performance data are required to be recorded.
4. Test - Verification though systematic exercising of the item under all appropriated conditions. Performance is quantitatively measured either during or after the controlled application of either real or simulated functional or environmental stimuli. The analysis of data derived from a test is an integral part of the test and may involve automated data reduction to produce the necessary results.

The verification program is an incremental process that is a companion to the assembly process. Component level requirements are verified first, followed by assembly level verification, to the system level verification. Requirements in this specification may have been verified at lower levels. Inspection of data from lower level component and assembly verifications will be used to verify appropriate requirements in this specification.

4.1.1 Responsibility for verifications.

Unless otherwise specified in the contract, the contractor is responsible for the performance of all verification requirements as specified herein. Except as otherwise specified in the contract, the contractor may use any facility suitable for the performance of the verification requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the verifications set forth in this specification.

4.1.2 Special tests and examinations.

All test measurement equipment and standards used in performance of the verifications specified herein shall have their calibration data traceable to NIST measurement standards.

4.2 Verification requirements.

All verification tests shall be performed using the preproduction sample as specified in CIR-SPC-0013. The sample shall be modified to the extent necessary to conduct testing. All CIR hardware/software deviating from the preproduction sample shall be documented. Written approval from the government quality assurance representative or the government quality assurance designee to proceed with the verification test using CIR hardware/software that deviates from the preproduction sample shall be obtained before beginning the verification test. Detailed verification requirements for the CIR are specified in CIR-PLN-0056.

4.3 Precedence.

All specifications, standards, exhibits, drawings, or other documents that are referenced in this specification are hereby incorporated as cited, with the exception of those documents specifically cited to be used for reference only.

4.4 Requirement/verification cross-reference.

The requirement/verification cross-reference is located in Appendix G.

5.0 PREPARATION FOR DELIVERY

This section gives the requirements for the preservation, packing, marking, and labeling of the CIR and its associated flight hardware for shipment to the launch site.

5.1 Preservation.

Not applicable.

5.2 Packing.

Packaging, handling, and transportation shall be in accordance with NHB 6000.1

5.2.1 Launch configured CIR.

The CIR in its launch configuration, including stowage items required to complete the on orbit configuration, shall be considered as Class I as specified in NHB 6000.1.

5.2.1.1 Cleanliness.

All surfaces of all hardware shall be cleaned to the VC - S cleanliness level as specified in SN-C-0005, except for those surfaces that are covered to maintain cleanliness for oxygen usage.

5.2.1.2 Procedures.

All flight hardware shall be packed according to its specific packing procedures in the designated containers.

5.2.2 Flight spares and other equipment.

Spares and all other CIR equipment shall be considered as Class III or higher as specified in NHB 6000.1.

5.3 Marking and labeling.

Not applicable.

5.4 Marking for shipment.

Marking of packaging containing pressurized gases and chemicals shall be in accordance with Department of Transportation regulations.

6.0 NOTES

There are no notes at this time.

APPENDIX A ACRONYMS AND ABBREVIATIONS

A.1 Scope.

This appendix lists the acronyms and abbreviations used in this document.

A.2 List of acronyms and abbreviations.

A	amperes
A_i	inherent availability
ac	alternating current
APID	application process identification
APM	Attached Pressurized Module
ARIS	Active Rack Isolation System
ATCA	Air Thermal Control Assembly
ATCS	Air Thermal Control System
atm	atmospheres
AWG	average wire gauge
BIT	built-in-test
C	centigrade, Celsius
cc	cubic centimeter
CCS	Calendar Segmented Time Code
CCSDS	Consultative Committee for Space Data Systems
CIR	Combustion Integrated Rack
CFU/m^3	Colony Forming Units/cubic meter
cm	centimeter
COF	Columbus Orbital Facility
COTS	commercial-off-the-shelf
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CUC	Unsegmented Time Code
C&W	caution and warning
dB	decibels
dBA	acoustic decibel level
dBm	decibels referenced to 1 mW
dc	direct current
deg	degrees
DOORS	Dynamic Object Oriented Requirements System
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPCE	Electrical Power Consuming Equipment
EPCU	Electrical Power Control Unit
EPS	Electrical Power System
equiv.	equivalent
ESA	European Space Agency
ESD	electrostatic discharge
F	Fahenheit

fc	foot-candles
FCF	Fluids and Combustion Facility
FCU	FOMA Control Unit
FEM	finite element modeling
FIR	Fluids Integrated Rack
FOMA	Fuel/Oxidizer Management Assembly
ft	feet
g	gravity
g^2/Hz	gravity squared/Hertz
GC	Gas Chomatograph
GFCI	Ground Fault Circuit Interrupters
GN2	gaseous nitrogen
GRC	Glenn Research Center
grms	gravity-root mean square
GSE	Ground Support Equipment
H	Halt symbol
HDRL	high rate data link
HFR	high frame rate
HiBMs	High Bit Depth/Multi-spectral
H	high resolution
HFM	high-rate frame multiplexer
Hz	Hertz
ICD	Interface Control Document
IDD	Interface Definition Document
IEEE	Institute of Electrical and Electronic Engineers
in.	inches
in-lb	inch-pounds
IOP	Input/Output Package
IPP	Image Processing Package
IR	infrared
IRD	Interface Requirements Document
IRE	Institute of Radio Engineers
ISPR	International Standard Payload Rack
ISS	International Space Station
ITCS	Internal Thermal Control System
IVA	Intravehicular Activity
IVS	Internal Video Subsystem
J	joules
JSC	Johnson Space Center
K	Kelvin
kg	kilograms
kg/h	kilograms per hour
KSC	Kennedy Space Center
kPa	kilopascals
LAN	local area network
lbs	pounds

lbf	pounds force
lbm	pounds per minute
LED	Light Emitting Diode
LISN	Line Impedance Simulation Network
LRDL	low rate data link
LSB	Least Significant Bit
M	meter
mA	milliampere
Mbits	megabits
Mbps	megabytes per second
MDM	Multiplexer-Demultiplexer
MDP	Maximum Design Pressure
MHz	megahertz
mm	millimeter
MMCH/Y	mean maintenance crew hours per year
mod.	modification
mph	miles per hour
MPLM	Multi-Purpose Logistics Module
MRDL	medium rate data link
ms	millisecond
m/s	meter/second
msec	millisecond
MSFC	Marshall Space Flight Center
MTBM	mean time between maintenance
MDT	mean delay time
MTTF	mean time to failure
MTTR	mean time to repair
N	Newton
N_2	nitrogen
N/A	Not applicable
NASDA	National Space Development Agency of Japan
NIRA	Non-Isolated Rack Assessment
nF	nanofarad
NIST	National Institute of Standards and Technology
nm	nanometer
N-m	Newton-meter
NRZI	Non Return to Zero Event
ns	nanosecond
NTSC	National Television Systems Committee
NVR	No verification required
O_2	oxygen
ORU	Orbital Replacement Unit
oz	ounces
Pa	Pascals
PCS	Portable Computer System
PFE	Portable Fire Extinguisher

PFM	Pulse Frequency Modulation
pf/m	picofarad per meter
PI	Principal Investigator
PIN	Part Identification Number
PDRP	Payload Display Review Panel
PRCU	Payload Rack Checkout Unit
psi	pounds per square inch
psia	pounds per square inch absolute
PSRP	Payload Safety Review Panel
PUL	Portable Utility Light
PVP	Payload Verification Plan
QD	quick disconnect
ref.	reference
rev.	revision
RH	relative humidity
RHA	Rack Handling Adapters
RMSA	Rack Maintenance Switch Assembly
RPC	Remote Power Controller
RPCM	Remote Control Power Module
RT	Remote Terminal
RUP	Rack Utility Panel
SAMS	Spacecraft Acceleration Measurement System
SAR	Shared Accommodations Rack
scc	standard cubic centimeter
SD	standard deviation
sec	second
SEE	single event effect
SMAC	Spacecraft Maximum Acceptable Concentration
SPL	sound pressure level
SRD	Science Requirements Document
SSC	Station Support Computer
STEP	Suitcase Test Environment for Payloads
TBC	To be confirmed
TBD	To be determined
TBE	Teledyne Brown Engineering
TCS	Thermal Control System
temp.	temperature
UIP	Utility Interface Panel
UOP	Utility Outlet Panel
US Lab	United States Laboratory Module
UV	ultraviolet
VC - S	Visibly Clean - Sensitive
Vdc	voltage direct current
VES/WGS	Vacuum Exhaust System/Waste Gas System
Vrms	voltage root mean square
W	watts

WFCA	Water Flow Control Valve
WTCS	Water Thermal Control System
μA	microampere
μg	microgravity
μsec	microsecond
Ω	ohm

APPENDIX B DEFINITIONS

B.1 Scope.

This section defines special terminology used in this document.

B.2 Definitions.

access port: Hole that allows penetration of the Portable Fire Extinguisher nozzle.

Adjunct Active Portable Equipment: Equipment operated outside the rack required to support nominal payload operations (including any required GFE).

acoustic reference: All sound pressure levels in decibels are referenced to 20 μPa.

active air exchange: Forced convection between two volumes. For example, forced convection between a subrack payload and the internal volume of an integrated rack, or forced convection between a subrack payload and the cabin air.

alignment marks: Straight or curved lines of sufficient length and width to allow alignment; applied to both mating parts. Align when the parts are in the installation position, and are visible during alignment and attachment.

amu (One Atomic Mass Unit): Equal to one-twelfth the mass of a carbon-12 atom; tile average atomic mass is called the atomic weight.

Applicable PI hardware/software: Hardware/software provided by the PI experiment required to perform a NASA Research Announcement experiment in the CIR.

boss: Protruding hard-points for GSE attachment.

brightness ratio: The ratio of the maximum light level on the work surface area to the minimum light level on the work surface area.

catastrophic hazard: Any hazard which causes loss of on orbit life sustaining system function.

Common Mode Noise: Refer to SSP 30482.

commonality: Identical in form, fit, and function.

Continuous Noise Source: A significant noise source which exists for a cumulative total of 8 hours or more in any 24-hour period.

critical hazard: Any hazard which may cause a non-disabling injury, severe occupational illness, loss of emergency procedures, or major damage to one of the following: the launch or servicing vehicle, manned base, an on orbit life sustaining function, a ground facility, or any critical support facility.

current limiting: The current is limited to a specific level plus or minus a percentage for tolerance.

detergent wipes: Detergent-saturated tissues used for interior surfaces and window cleaning.

disinfecting wipes: Tissue saturated with a disinfecting cleansing agent or agents for cleanup of biological spills and biologically contaminated surfaces.

dry wipes: Utility wipes used for compartment and equipment cleaning and spill clean-up.

electromagnetic compatibility (EMC): The capability of systems and all associated subsystems/equipment to perform within design limits without degradation due to the Electromagnetic Effect encountered during accomplishment of the assigned mission. The deliverable end item compatibility test is as described in paragraph 3.6.2 of SSP 30243.

electromagnetic interference (EMI): Any electromagnetic disturbance, phenomenon, signal, or emission (man-made or natural) which causes equipment performance outside of the equipment's design limits. Testing is described in SSP 30237 and SSP 30238, as referenced by SSP 57000, paragraph 3.2.4.4.

emergency condition: Toxic atmosphere, rapid cabin depressurization, or fire.

EPCE: Equipment that consumes electrical power including battery powered equipment.

fire event: Localized or propagating combustion, pyrolysis, smoldering, or other thermal degradation process characterized by the potentially hazardous release of energy, particulates, or gasses.

GSE Plane: A reference plane that is defined by the front surface of the four rack GSE bosses.

hazard: The presence of a potential risk situation caused by an unsafe act or condition.

health and status data: Information originating at the payload and passed to the respective payload MDM that provides the crew and the ground confirmation of payload performance, operational state, resource consumption, and assurance that the payload is operating within the safety guidelines as defined by the Payload Safety Review Panel and the ISS Flight Rules. Some examples of payload health and status data are subsystem status (power, voltages, currents, temperatures, pressures, fluid flow velocities, warning indicators, error messages/codes, etc.), digital communications system statistics (1553, Ethernet, and high rate system status, etc.), and video system status (camera and video recorder on/off indications, synchonization indicators, etc.).

integrated rack: The ISPR and all other subrack equipment which operates within a rack.

Intermittent Noise Source: A significant noise source which exists for a cumulative total of less than 8 hours in a 24-hour period.

Line Impedance Stabilization Network: An electrical circuit, including resistance, capacitance, and inductance, used to simulate a specific electrical power bus.

maintenance: The scheduled or unscheduled activity (inspections, preventive and corrective actions, restorations, replacement of assemblies and components, and resupply operations) intended to keep the proper functioning of CIR hardware and software.

maintenance item: Any assembly or component designed to be replaceable on orbit to maintain the proper functioning of CIR hardware.

mils: Length measurement equal to 0.001 in.

non-normal: Pertaining to performance of the Electrical Power System outside the nominal design due to ISS system equipment failure, fault clearing, or overload conditions.

On orbit Momentary Protrusions: Payload obstructions which typically would protrude for a very short time or could be readily eliminated by the crew at any time. Momentary protrusions include only the following: drawer/door/cover replacement or closure.

On orbit Permanent Protrusion: A payload hardware item which is not ever intended to be removed.

On orbit Protrusions for Keep Alive Payloads: A protrusion which supports and/or provides the uninterrupted resources necessary to run an experiment. On orbit protrusions for Keep Alive Payloads includes only power/data cables and thermal hoses.

On orbit Semi-Permanent Protrusion: A payload hardware item which is typically left in place but can be removed by the crew with hand operations or standard IVA tools.

> Example: SIR and ISIS drawer handles, other equipment that does not interfere with crew restraints, and mobility aids.

On orbit Temporary Protrusion: A payload item which is typically located in the aisle for experiment purposes only. These items should be returned to their stowed configuration when not being used.

> Example: Front panel mounted equipment.

operate: Perform intended design functions given specified conditions.

Orbital Replacement Unit: Any unit mounted to the exterior of an assembly that can be removed and replaced with an identical unit while on orbit. Items internal to hardware, such as electronic circuit boards and internal disk drives, are not considered ORU’s.

out-of-tolerance: Any condition outside of normal or specified operational limits.

potential fire source: Any electrical, chemical, or other energy source capable of creating a fire event (e.g., electrically powered equipment).

protrusion: A payload hardware item which extends beyond the GSE plane.

rack equivalent: The volume equal to the total internal volume of one empty ISPR.

reusable wipes: Utility handwipes that can be impregnated or dampened with premixed evaporative detergent/biocidal solutions or with water.

safety-critical: Having the potential to be hazardous to the safety of hardware, software, and personnel.

specularity: The ratio of the flux leaving a surface or medium by regular (specular) reflection to the incident flux.

standard conditions: Measured volumes of gasses are generally recalculated to 0°C temperature and 760 mm Hg pressure, which have been arbitrarily chosen as standard conditions.

training: To educate people in the design, operation, maintenance, and troubleshooting aspects of the CIR.

up-mass: The mass of equipment to be transported from the ground to the ISS.

up-volume: The volume of equipment to be transported from the ground to the ISS.

vented conditions: Condition (temperature and pressure) of the gas in the experiment chamber as the chamber is opened to the ISS VES/VGS.

VES/WGS: Vacuum Exhaust System and/or Waste Gas System. The USL, JEM, and APM each have similar systems to vent gases to space from an experiment chamber. The system in the USL is the Vacuum Exhaust System and the systems in the JEM and APM are the Waste Gas Systems.

wire derating: Wire is derated based on the current flow, environment, and electrical circuitry that operates within an integrated rack or within Electrical Power Consuming Equipment individual boxes.

APPENDIX C CIR INTERNAL PHYSICAL INTERFACES

C.1 Scope.

This section gives the CIR internal physical interfaces.

C.2 CIR internal physical interfaces.

The CIR internal physical interface descriptions are given in below. See the respective product specifications for detailed interface description.

C.2.1 ISPR rack to CIR attachment interfaces.

a. ATCU to Rack Attachment Bracket

b. Optics Bench to Rack Attachment Bracket

c. EPCU Bracket to Rack Attachment Bracket

d. IOP Bracket to Rack Attachment Bracket

e. Center Post to Rack Attachment Bracket

f. Optics Bench Slide to Rack Attachment Bracket

g. GIS to Rack Attachment Bracket

h. Smoke Detector to Rack Attachment Bracket

i. WTCS to Rack Attachment Bracket

C.2.2 CIR component to optics bench attachment.

a. High Percentage Oxygen Supply Manifold

b. Diluent/Premixed Supply Manifold

c. Nitrogen/High Pressure Supply Manifold

d. Fuel/Pre-mixed Fuel Supply Manifold

e. Exhaust Vent Manifold

f. Adsorber Cartridge Brackets

g. Manual Vent Valve Manifold

h. GC Supply Manifold Brackets

i. Gas Chromatograph

j. SAMS Head

k. Oxygen Senor Enclosure

l. Valve timers Enclosure

m. Combustion Chamber

n. FOMA Control Unit.

o. PI Specific electronic Box

p. IPP

APPENDIX D CIR INTERNAL ELECTRICAL/DATA INTERFACES.

D.1 Scope.

This section gives the CIR internal electrical/data interfaces.

D.2 CIR internal electrical/data interfaces.

The CIR internal electrical/data interfaces are given in Table XXX..

Table XXX. CIR internal electrical/data interfaces

Function	Start	Part #	Mate Part #	End	Part #	Mate Part #
ELEC. INTFC. FOR DIAGNOSTICS	JPIL1	DSXN3R-S106P-S106P-S55S-6301	"End" same as mate	PPIL1 ON CSAP	DSXN3P-S106S-S106S-S55P-6001	"Start" same as mate
ELEC. INTFC. FOR DIAGNOSTICS	JPIL2	DSXN1R-S26S-6301	"End" same as mate	PPIL2 ON CSAP	DSXN1P-S26P-6001	"Start" same as mate
ELEC. INTFC. FOR DIAGNOSTICS	JFCU1	DSXN3R-S106P-S106P-S33C4S-6301	"End" same as mate	PFCU1 ON FCU	DSXN3P-S106S-S106S-S33C4P-6001	"Start" same as mate
ELEC. INTFC. FOR DIAGNOSTICS	JFCU2	DSXN1R-S106P-6301	"End" same as mate	PFCU2 ON FCU	DSXN1P-S106S-6001	"Start" same as mate
ELEC. INTFC. FOR DIAGNOSTICS	JOPB14	DSXN2R-S26S-S26S-6301	"End" same as mate	POPB14 ON FPP	DSXN2P-S26P-S26P-6001	"Start" same as mate
22AWG PI config. to chamber	POPB5	D38999/26FH35PN	D38999/24FH35SN	PCTC1	D38999/26FH35SN	D38999/20FH35PN
20AWG PI config. to chamber	POPB6	D38999/26FH55PA	D38999/24FH55SA	PCTC2	D38999/26FH55SA	D38999/20FH55PA
16AWG Power & PI config. to chamber	POPB7	D38999/26FH21PB	D38999/24FH21SB	PCTC3	D38999/26FH21SB	D38999/20FH21PB
22AWG PI config. to chamber	POPB8	D38999/26FH35PC	D38999/24FH35SC	PCTC4	D38999/26FH35SC	D38999/20FH35PC
BENCH POWER 1	POPB1	D38999/26FH21SN	D38999/24FH21PN	PEPC12	D38999/26FG16PN	D38999/20FG16SN
				PEPC13	D38999/26FG16PN	D38999/20FG16SN
				PEPC20	D38999/26FG16PN	D38999/20FG16SN
				PEPC21	D38999/26FG16PN	D38999/20FG16SN
BENCH POWER 2	POPB2	D38999/26FH21SA	D38999/24FH21PA	PEPC14	D38999/26FG16PN	D38999/20FG16SN
				PEPC15	D38999/26FG16PN	D38999/20FG16SN
				PEPC16	D38999/26FG16PN	D38999/20FG16SN
				PEPC18	D38999/26FG16PN	D38999/20FG16SN
				PEPC19	D38999/26FG16PN	D38999/20FG16SN
IOP POWER	PEPC17	D38999/26FG16PN	D38999/20FG16SN	PIOP3	D38999/26FE8SN	D38999/24FE8PN
BENCH DATA	PIOP2	D38999/26FH35PN	D38999/24FH35SN	POPB3	D38999/26FH35PN	D38999/24FH35SN
MAIN POWER	J1	NATC07T25LN3PN	**NATC06G25LN3SN**	PEPC1	MS3459L28-22S	MS3452L28-22P
AUX POWER	J2	NATC07T25LN3PA	**NATC06G25LN3SA**	PEPC2	MS3459L28-22S	MS3452L28-22P
ESS	J6	D38999/24FA98SN	D38999/26FA98PN	PEPC7	D38999/26FC35PN	D38999/20FC35SN
HRDL/CVIT	PIOP6	D38999/26FB2PN	D38999/24FB2SN	J7	NATC07T13N4SN	**NATC06G13N4PN**
				J16	NATC07T15N97SB	**NATC06G15N97PB**
SSC DATA	PIOP5	D38999/26FC98PN	D38999/24FC98SN	J5	MS3474L14-12S	**MS3475L14-12P**

				J11	MS247468T11F35S	**MS27467T11F35P**
				J12	BJ-76	**PL75-47**
EEU CONTROL	PEEU4	D38999/26FC8SN	D38999/24FC8PN	PFAN1		
FDSS/ARIS POWER	PEPC3	D38999/26FG16PA	D38999/20FG16SA	**P1**	**NATC06G15N35SN**	**NATC07H15N35PN**
				P4	NATC06G15N19SN	**NATC07T15N19PN**
PI 120V	JTBD			PEPC4	D38999/26FG16PA	D38999/20FG16SA
VALVE 1	PWFV1-1	GFE	GFE	PWFC1-1	GFE	GFE
SENSOR 1	PWFS1-1	GFE	GFE	PWFC2-1	GFE	GFE
VALVE 2	PWFV1-2	GFE	GFE	PWFC1-2	GFE	GFE
SENSOR 2	PWFS1-1	GFE	GFE	PWFC 2-2	GFE	GFE
EEU POWER	PEPC22	D38999/26FG16PN	D38999/20FG16SN	PEEU3	D38999/26FC8PN	D38999/24FC8SN
				PWFC3-1	D38999/26FC98SN	D38999/24FC98PN
				PWFC3-2	D38999/26FC98SN	D38999/24FC98PN
EEU DATA	PEEU2	D38999/26FC35PA	D38999/24FC35SA	PFAN1		
				PWFC3-1	D38999/26FC98SN	D38999/24FC98PN
				PWFC3-2	D38999/26FC98SN	D38999/24FC98PN
FDS/MAINT.	J43	NAT07T13N35PA		P1	**NATC06G15N35SN**	**NATC07H15N35PN**
				PEEU1	D38999/26FC35PN	D38999/24FC35SN
				J44	D38999/24FA35SN	D38999/26FA35PN
STATION/EEU DATA	PIOP4	D38999/26FD35PN	D38999/24FD35SN	PEEU1	D38999/26FC35PN	D38999/24FC35SN
				P1	**NATC06G13N35SN**	**NATC07T13N35PN**
				PEPC5	**PL155-47**	BJ-154
				PEPC6	**PL155-47**	BJ-154
				J3	NATC07T15N35PN	**NATC06G15N35SN**
				J4	NATC07T15N35PA	**NATC06G15N35SA**
				J46	NATC07T11N35PA	**NATC06G11N35SA**
				J47	**NATC07T11N35PB**	**NATC06G11N35SB**
THERMISTORS	PEEU1	D38999/26FC35PN	D38999/24FC35SN	FAN IN	AD590	Device, no mate
				FAN OUT	AD590	Device, no mate
				H.EX. IN	AD590	Device, no mate

				H.EX. OUT	AD590	Device, no mate
				PRIM. WATER	AD590	Device, no mate
				SEC. WATER	AD590	Device, no mate
				STATION IN.	AD590	Device, no mate
				STATION OUT.	AD590	Device, no mate
CIR RTR IMAGE	J8	MTP-ADPT	MTP-012M-SM, MTFA-12SM5	PFPP13	MTP-012M-SM, MTFA-12SM5	MTP-ADPT
CIR/FIR RTR CAN, EtherNet, Sync, and Video	J9	MTP-ADPT	MTP-012M-MM, MTF-12MM7	PIOP7	MTP-012M-SM, MTFA-12SM5	MTP-ADPT
FIR RTR IMAGE	J10	Not Used in CIR				
120 TO PI	PI SPECIFIC AVIONICS			PTBD		
SSC POWER	P5	**MS3475L14-12P**	**MS3474L14-12S**	P?	**GFE**	**GFE**
SSC ETHERNET	P11	**MS27467T11F35P**	**MS27468T11F35S**	P?	**GFE**	**GFE**
SSC VIDEO	P12	**PL75-47**	**BJ-74**	P?	**GFE**	**GFE**
DEVICE ESS	EPCU SHUTOFF SWITCH			P6	**D38999/26FA98PN**	**D38999/24FA98SN**
SAMS	PIOP1	D38999/26FB35PN	D38999/24FB35SN	PSAM1		

APPENDIX E CIR INTERNAL GAS INTERFACES.

E.1 Scope.

This section gives the CIR internal gas interfaces.

E.2 CIR internal gas interfaces.

The CIR internal gas interfaces are given in Table XXXI.

Table XXXI. CIR internal gas interfaces

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
382	GC	GCI	Y	-----	Fitting to Pressure Regulator Inlet	1/8 NPT
383	GC	GCI	Y	-----	Fitting to Pressure Regulator Outlet	1/8 NPT
110	GSDP	Fuel Man.	N	MUF4	Muffler to bleed valve	10-32 thead
153	GSDP	N2HP Man	N	MUF1	Muffler to bleed valve	10-32 thead
160	GSDP	HPO2 Man	N	MUF2	Muffler to bleed valve	10-32 thead
245	GC	Ar manifold	N	MUF7	Muffler to bleed valve	10-32 thead
268	GC	He manifold	N	MUF6	Muffler to bleed valve	10-32 thead
291	GC	-----	N	MUF5	Muffler to bleed valve	10-32 thead
320	GSDP	Dil. Man.	N	MUF3	Muffler to bleed valve	10-32 thead
332	GC	GCI	Y	-----	Manifold Inlet Port	10-32 thead
334	GC	GCI	Y	-----	Manifold Exit Port	10-32 thead
343	GC	GCI	Y	-----	Manifold Inlet Port	10-32 thead
354	GC	GCI	Y	-----	Inlet Port to SV23	10-32 thead
355	GC	GCI	Y	-----	Outlet Port from SV23	10-32 thead
358	GC	GCI	Y	-----	Inlet Port to Manifold	10-32 thead
360	GC	GCI	Y	-----	Inlet Port to Manifold	10-32 thead
362	GC	GCI	Y	-----	Inlet Port to Manifold	10-32 thead
366	GC	GCI	Y	-----	Exit Port from Manifold	10-32 thead
371	GC	GCI	Y	-----	Inlet Port to Manifold	10-32 thead
492	GC	GCI	N	-----	Outlet Port to Manifold	10-32 thead
494	GC	GCI	N	-----	Outlet Port to Manifold	10-32 thead
12	GSDP	Fuel Man.	N	MFC1	Mass Flow Controller to Manifold	2 Single O-rings
26	GSDP	Dil. Man.	N	MFC2	Mass Flow Controller to Manifold	2 Single O-rings

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
40	GSDP	HPO2 Man	N	MFC3	Mass Flow Controller to Manifold	2 Single O-rings
54	GSDP	N2HP Man.	N	MFC4	Mass Flow Controller to Manifold	2 Single O-rings
97	IRR	-----	N	MV5	3-Way manual Valve to IRR	3 Single O-rings
321	EVP	MVB	Y	MV4	Block for MV4	3 Single O-rings
486	GC	GCI	N	-----	Manifold Inlet Port	5/16-24 thead
487	GC	GCI	N	-----	Manifold Inlet Port	5/16-24 thead
346	GC	GCI	Y	-----	Manifold Exit Port	5/16-24 thead
386	GC	GCI	Y	-----	Tubing to Tubing	Ag Braze
388	GC	GCI	Y	-----	Tubing to Tubing	Ag Braze
404	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
405	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
406	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
407	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
408	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
409	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
410	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
411	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
412	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
413	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
414	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
415	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
416	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
417	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
418	GC	GCI		-----	Tubing to Y Connectors	Ag Braze
419	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
420	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
421	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
422	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
423	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
424	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
425	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
426	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
427	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
428	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
429	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
430	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
431	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
432	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
433	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
434	GC	GCI		-----	Tubing to Column Tubing	Ag Braze

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
435	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
436	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
437	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
438	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
439	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
440	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
441	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
442	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
443	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
444	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
445	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
446	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
447	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
448	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
449	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
450	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
451	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
452	GC	GCI		-----	Tubing to Column Tubing	Ag Braze
490	GC	GCI	N	-----	Tubing to Tubing connection	Ag Braze
491	GC	GCI	N	-----	Tubing to Tubing connection	Ag Braze
265	GC	GCI	N	-----	Ar GCI panel mount	bulkhead
288	GC	GCI	N	-----	He GCI panel mount	bulkhead
309	GC	GCI	N	-----	CG GCI panel mount	bulkhead
310	GC	GCI	Y	-----	Sample line GCI panel mount	bulkhead
313	GC	GCI	N	-----	Vent line GCI panel mount	bulkhead
120	EVP	O2 Sensor	Y	Reducer	reducer to 1/2" side	Comp. Fitting
121	EVP	O2 Sensor	Y	Reducer	reducer to 1/16" side	Comp. Fitting
123	EVP	Tube Route	Y	-----	reducer to 1/4" tube side	Comp. Fitting
347	GC	GCI	Y	-----	Tube to fitting	Comp. Fitting
348	GC	GCI	Y	-----	Tube to elbow fitting - 2 places	Comp. Fitting
385	GC	GCI	Y	-----	Tubing to Union Tee - 3 places	Comp. Fitting
488	GC	GCI	N	-----	Tube to Union Elbow Fitting - 2 places	Comp. Fitting
489	GC	GCI	N	-----	Tube to Union Elbow Fitting - 2 places	Comp. Fitting
329	GC	GCI	Y	-----	Inlet Port to Pump 3	Crimp Joint
330	GC	GCI	Y	-----	Exit port from Pump 3	Crimp Joint
331	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
335	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
336	GC	GCI	Y	-----	Tube to CV3 inlet	Crimp Joint
337	GC	GCI	Y	-----	Tube to CV3 outlet	Crimp Joint

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
338	GC	GCI	Y	-----	Tube to Tee fitting - 3 places	Crimp Joint
339	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
340	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
341	GC	GCI	Y	-----	Tube to Tee fitting - 3 places	Crimp Joint
342	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
351	GC	GCI	Y	-----	Tube to CV3 inlet	Crimp Joint
352	GC	GCI	Y	-----	Tube to CV3 outlet	Crimp Joint
353	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
356	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
357	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
359	GC	GCI	Y	-----	Tube from Pump 5 to Fitting	Crimp Joint
361	GC	GCI	Y	-----	Tube from Pump 4 to Fitting	Crimp Joint
363	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
364	GC	GCI	Y	-----	Inlet to Pump 4	Crimp Joint
367	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
370	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
372	GC	GCI	Y	-----	Tube to Tee fitting - 3 places	Crimp Joint
373	GC	GCI	Y	-----	Tube to CV5 Outlet	Crimp Joint
374	GC	GCI	Y	-----	Tube to CV5 Inlet	Crimp Joint
381	GC	GCI	Y	-----	Tube to fitting	Crimp Joint
454	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
456	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
458	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
460	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
462	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
464	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
465	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
466	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
467	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
468	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
469	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
470	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
471	GC	GCI	Y	-----	Tubing to Tee Fitting - 3 places	Crimp Joint
472	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
473	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
474	GC	GCI	Y	-----	Tubing to Reducer Union - 2 places	Crimp Joint
475	GC	GCI	Y	-----	Tubing to Reducer Union - 2 places	Crimp Joint
476	GC	GCI	Y	-----	Tubing to Reducer Union - 2 places	Crimp Joint
477	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
478	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
479	GC	GCI	Y	-----	Tubing to Fitting	Crimp Joint
493	GC	GCI	N	-----	Tubing to Fitting	Crimp Joint
495	GC	GCI	N	-----	Tubing to Fitting	Crimp Joint
496	GC	GCI	N	-----	Tubing to Tee Fitting - 3 places	Crimp Joint

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
497	GC	GCI	Y	-----	Exit port from Pump 5	Crimp Joint
498	GC	GCI	Y	-----	Exit port from Pump 4	Crimp Joint
387	GC	GCI	Y	-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
389	GC	GCI	Y	-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
390	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
391	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
392	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
393	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
394	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
395	GC	GCI	N	-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
396	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
397	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
398	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
399	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
400	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
401	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
402	GC	GCI		-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
403	GC	GCI	N	-----	Tubing to Regulator Manifold	Dbl. O-ring Comp.
125	EVP	Exhst Man	Y	SV24	Solenoid Valve to Manifold	Double O-ring
126	EVP	Exhst Man	Y	SV22	Solenoid Valve to Manifold	Double O-ring
127	EVP	Exhst Man	Y	SV11	Solenoid Valve to Manifold	Double O-ring
128	EVP	Exhst Man	Y	SV1	Solenoid Valve to Manifold	Double O-ring
5	GSDP	Fuel Man.	N	-----	QD Plate to Manifold	Double O-ring
6	GSDP	Fuel	N	SV6	Solenoid Valve to Manifold	Double O-ring

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
		Man.				
7	GSDP	Fuel Man.	N	PR2	Pressure Regulator to Manifold	Double O-ring
10	GSDP	Fuel Man.	N	SV7	Solenoid Valve to Manifold	Double O-ring
13	GSDP	Fuel Man.	N	SV8	Solenoid Valve to Manifold	Double O-ring
19	GSDP	Dil. Man.	N	-----	QD Plate to Manifold	Double O-ring
20	GSDP	Dil. Man.	N	SV10	Solenoid Valve to Manifold	Double O-ring
21	GSDP	Dil. Man.	N	PR3	Pressure Regulator to Manifold	Double O-ring
24	GSDP	Dil. Man.	N	SV9	Solenoid Valve to Manifold	Double O-ring
27	GSDP	Dil. Man.	N	SV17	Solenoid Valve to Manifold	Double O-ring
33	GSDP	HPO2 Man	N	-----	QD Plate to Manifold	Double O-ring
34	GSDP	HPO2 Man	N	SV3	Solenoid Valve to Manifold	Double O-ring
35	GSDP	HPO2 Man	N	PR1	Pressure Regulator to Manifold	Double O-ring
38	GSDP	HPO2 Man	N	SV4	Solenoid Valve to Manifold	Double O-ring
41	GSDP	HPO2 Man	N	SV5	Solenoid Valve to Manifold	Double O-ring
47	GSDP	N2HP Man.	N	-----	QD Plate to Manifold	Double O-ring
48	GSDP	N2HP Man.	N	SV13	Solenoid Valve to Manifold	Double O-ring
49	GSDP	N2HP Man.	N	PR4	Pressure Regulator to Manifold	Double O-ring
52	GSDP	N2HP Man.	N	SV12	Solenoid Valve to Manifold	Double O-ring
55	GSDP	N2HP Man.	N	SV2	Solenoid Valve to Manifold	Double O-ring
57	GSDP	N2HP Man.	N	SV28	Solenoid Valve to Manifold	Double O-ring
89	GSDP	SMM	N	SV14	Solenoid Valve to SMM	Double O-ring
91	IRR	-----	Y	SV18	Solenoid Valve to IRR	Double O-ring
93	IRR	-----	Y	SV16	Solenoid Valve to IRR	Double O-ring
95	IRR	-----	Y	SV20	Solenoid Valve to IRR	Double O-ring
103	IRR	-----	Y	SV15	Solenoid Valve to IRR	Double O-ring
104	IRR	-----	Y	SV21	Solenoid Valve to IRR	Double O-ring
117	End Cap	-----	Y	SV19	Solenoid Valve to End Cap	Double O-ring
174	EVP	Vent Man	Y	SV23	Solenoid Valve to Manifold	Double O-ring
175	EVP	Vent Man	Y	SV29	Solenoid Valve to Manifold	Double O-ring

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
259	GC	Ar manifold	N	SV26	Solenoid valve to manifold	Double O-ring
282	GC	He manifold	N	SV25	Solenoid valve to manifold	Double O-ring
303	GC	-----	N	SV27	Solenoid valve to manifold	Double O-ring
375	GC	GCI	N	SV30	Solenoid Valve to Manifold	Double O-ring
376	GC	GCI	N	SV31	Solenoid Valve to Manifold	Double O-ring
453	GC	GCI	Y	-----	Fitting to Column Port	Luer Lock
455	GC	GCI	Y	-----	Fitting to Column Port	Luer Lock
457	GC	GCI	Y	-----	Fitting to Column Port	Luer Lock
459	GC	GCI	Y	-----	Fitting to Column Port	Luer Lock
461	GC	GCI	Y	-----	Fitting to Column Port	Luer Lock
463	GC	GCI	Y	-----	Fitting to Column Port	Luer Lock
155	EVP	ACA	Y	MV9	manual valve AC side port to fitting	Metal Gasket
157	EVP	ACA	Y	MV10	manual valve AC side port to fitting	Metal Gasket
179	EVP	DPS-MFC	Y	----	Mass Flow Controller to Fitting	Metal Gasket
181	EVP	MFC-SV	Y	----	Mass Flow Controller to Fitting	Metal Gasket
200	EVP	Pthu - vent	Y	----	Vent Man Inlet Port to Fitting	Metal Gasket
203	EVP	Vent-Pthu	Y	----	Vent Man Exit Port to Fitting	Metal Gasket
59	GSDP	Fuel - IRR	N	-----	Fuel Manifold Exit Port to Fitting	Metal O-ring
62	GSDP	Fuel - IRR	N	-----	Fitting to IRR Port	Metal O-ring
63	GSDP	Dil - SMM	N	-----	Diluent Manifold Exit Port to Fitting	Metal O-ring
66	GSDP	Dil - SMM	N	-----	Fitting to SMM Port	Metal O-ring
68	GSDP	O2 - SMM	N	-----	Oxygen Manifold Exit Port to Fitting	Metal O-ring
71	GSDP	O2 - SMM	N	-----	Fitting to SMM Port	Metal O-ring
73	GSDP	N2 - SMM	N	-----	Nitrogen Manifold Exit Port to Fitting	Metal O-ring
76	GSDP	N2 - SMM	N	-----	Fitting to SMM Port	Metal O-ring
78	GSDP	N2 - IRR	N	-----	H. P. Exit Port on Man. - Fitting	Metal O-ring
81	GSDP	N2 - IRR	N	-----	Fitting to IRR Port	Metal O-ring
133	EVP	IRR-Exh	Y	----	Exhst Man Inlet Port to Fitting	Metal O-ring
136	EVP	Exh-AC	Y	----	Exhst Man Exit Port to Fitting	Metal O-ring
139	EVP	Exh-GC	Y	----	Exhst Man Inlet Port to Fitting	Metal O-ring

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
142	EVP	Exh-SM	Y	----	Exhst Man Inlet Port to Fitting	Metal O-ring
150	EVP	ACA-Exh	Y	----	QD7 Port to Fitting	Metal O-ring
161	EVP	ACA-flexh	Y	----	QD6 coupler half to flexhose	Metal O-ring
166	EVP	MVB-Pthu	Y	----	MVB Exit Port to Fitting	Metal O-ring
190	EVP	Pthu-vent	Y	----	Vent Man Inlet Port to Fitting	Metal O-ring
193	EVP	Vent-Pump	Y	----	Vent Man Exit Port to Fitting	Metal O-ring
196	EVP	Vent - DPS	Y	----	Vent Man Exit Port to Fitting	Metal O-ring
206	EVP	Vent-Pump	Y	----	Pump 1 Inlet Port to Fitting	Metal O-ring
209	EVP	Vent-Pump	Y	----	Pump 2 Inlet Port to Fitting	Metal O-ring
212	EVP	Vent-Pump	Y	----	Pump 1 Exit Port to Fitting	Metal O-ring
215	EVP	Vent-Pump	Y	----	Pump 2 Exit Port to Fitting	Metal O-ring
219	EVP	Pumps - F7	Y	----	Inline Filter to Fitting	Metal O-ring
221	EVP	F7-Endcap	Y	----	Inline Filter to Fitting	Metal O-ring
226	EVP	-----	Y	----	Pass-thu port to fitting	Metal O-ring
229	EVP	-----	Y	----	Pass-thu port to fitting	Metal O-ring
252	GC	Ar manifold	N	-----	Fitting at Manifold Inlet Port	Metal O-ring
254	GC	Ar manifold	N	-----	Fitting at Manifold Outlet Port	Metal O-ring
261	GC	Ar manifold	N	-----	Ar manifold exit port to fitting	Metal O-ring
264	GC	Ar - GCI	N	-----	Fitting to GCI panel	Metal O-ring
275	GC	He manifold	N	-----	Fitting at Manifold Inlet Port	Metal O-ring
277	GC	He manifold	N	-----	Fitting at Manifold Outlet Port	Metal O-ring
284	GC	He manifold	N	-----	He manifold exit port to fitting	Metal O-ring
287	GC	He - GCI	N	-----	Fitting to GCI panel	Metal O-ring
298	GC	-----	N	-----	Fitting at Manifold Inlet Port	Metal O-ring
300	GC	-----	N	-----	Fitting at Manifold Outlet Port	Metal O-ring
305	GC	-----	N	-----	CG manifold exit port to fitting	Metal O-ring
308	GC	-----	N	-----	Fitting to GCI panel	Metal O-ring

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
311	GC	GCI	Y	-----	Fitting to GCI panel	Metal O-ring
314	GC	GCI	N	-----	Fitting to GCI panel	Metal O-ring
316	GSDP	SMM	N	-----	Fitting to SMM Port	Metal O-ring
318	End Cap	-----	Y	-----	Fitting to SV19 Port	Metal O-ring
323	IRR	-----	Y	-----	Fitting to SV15 Outlet Port	Metal O-ring
328	GC	GCI	Y	-----	Fitting to Bulkhead	Metal O-ring
350	GC	GCI	Y	-----	Fitting to Bulkhead	Metal O-ring
369	GC	GCI	Y	-----	Fitting to Bulkhead	Metal O-ring
378	GC	GCI	N	-----	Fitting to Bulkhead	Metal O-ring
380	GC	GCI	N	-----	Fitting to Bulkhead	Metal O-ring
481	GC	GCI	N	-----	Fitting to Manifold Port	Metal O-ring
484	GC	GCI	Y	-----	Fitting to Manifold Port	Metal O-ring
85	GSDP	SMM	N	-----	Static Mixer Exit Port to Fitting	Metal O-ring
88	GSDP	SMM	N	-----	Fitting to IRR Port	Metal O-ring
130	EVP	IRR-Exh	Y	----	Exhst Man Inlet Port to Fitting	Metal O-ring
145	EVP	Exh-Pthu	Y	----	Exhst Man Exit Port to Fitting	Metal O-ring
168	EVP	MVB	Y	----	MVB Inlet Port to Fitting	Metal O-ring
170	EVP	MVB	Y	----	MVB Inlet Port to Fitting	Metal O-ring
184	EVP	Pthu-vent	Y	----	Vent Man Inlet Port to Fitting	Metal O-ring
187	EVP	DPS-MFC	Y	----	Vent Man Exit Port to Fitting	Metal O-ring
232	EVP	-----	Y	----	Pass-thu port to fitting	Metal O-ring
235	EVP	-----	Y	----	Pass-thu port to fitting	Metal O-ring
238	EVP	-----	Y	----	Pass-thu port to fitting	Metal O-ring
241	EVP	-----	Y	----	Pass-thu port to fitting	Metal O-ring
325	IRR	-----	Y	-----	Fitting to SV21 Port	Metal O-ring
223	IRR	-----	Y	----	Outlet to GC from SV15	MS 33649-02
101	IRR	-----	Y	TM2	Thermister to IRR	MS 33649-02
102	IRR	-----	Y	TM1	Thermister to IRR	MS 33649-02
113	End Cap	-----	Y	TM3	Thermister to End Cap	MS 33649-02
114	End Cap	-----	Y	TM4	Thermister to End Cap	MS 33649-02
67	GSDP	Dil - SMM	N	-----	SMM Port to SMM	MS 33649-04
72	GSDP	O2 - SMM	N	-----	SMM Port to SMM	MS 33649-04
77	GSDP	N2 - SMM	N	-----	SMM Port to SMM	MS 33649-04
82	GSDP	N2 - IRR	N	-----	IRR Port to IRR	MS 33649-04
90	GSDP	SMM	N	-----	SMM Port (Vent) to Fitting	MS 33649-04
109	IRR	-----	N	-----	Inlet to SV16 from Fuel Manifold	MS 33649-04
118	End Cap	-----	Y	-----	Outlet from SV19 to EVP	MS 33649-04
132	EVP	Exhst Man	Y	----	Inlet Port to Manifold	MS 33649-04

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
135	EVP	Exhst Man	Y	----	Exit Port to Manifold	MS 33649-04
138	EVP	Exhst Man	Y	----	Inlet Port to Manifold	MS 33649-04
141	EVP	Exhst Man	Y	----	Inlet Port to Manifold	MS 33649-04
149	EVP	ACA	Y	----	Inlet Port at QD7	MS 33649-04
163	EVP	MVB	Y	----	Inlet Port to Manifold	MS 33649-04
165	EVP	MVB	Y	----	Exit Port to Manifold	MS 33649-04
192	EVP	Vent Man	Y	----	Exit Port to Manifold	MS 33649-04
195	EVP	Vent Man	Y	----	Exit Port to Manifold	MS 33649-04
205	EVP	Pumps	Y	Pump 1	Inlet Port to Pumps	MS 33649-04
208	EVP	Pumps	Y	Pump 2	Inlet Port to Pumps	MS 33649-04
211	EVP	Pumps	Y	Pump 1	Exit Port to Pumps	MS 33649-04
214	EVP	Pumps	Y	Pump 2	Exit Port to Pumps	MS 33649-04
225	EVP	-----	Y	----	Pass-thu port on front of optics plate	MS 33649-04
228	EVP	-----	Y	----	Pass-thu port on back of optics plate	MS 33649-04
253	GC	Ar manifold	N	-----	Manifold Exit Port to Regulator	MS 33649-04
255	GC	Ar manifold	N	-----	Manifold Inlet Port from Regulator	MS 33649-04
260	GC	Ar manifold	N	-----	Exit port to manifold	MS 33649-04
276	GC	He manifold	N	-----	Manifold Exit Port to Regulator	MS 33649-04
278	GC	He manifold	N	-----	Manifold Inlet Port from Regulator	MS 33649-04
283	GC	He manifold	N	-----	Exit port to manifold	MS 33649-04
299	GC	-----	N	-----	Manifold Exit Port to Regulator	MS 33649-04
301	GC	-----	N	-----	Manifold Exit Port to Regulator	MS 33649-04
304	GC	-----	N	-----	Exit port to manifold	MS 33649-04
480	GC	GCI	N	-----	Port for Solenoid Manifold	MS 33649-04
483	GC	GCI	Y	-----	Port for Solenoid Manifold	MS 33649-04
98	IRR	-----	Y	PS5	Pressure Switch to IRR	MS 33649-04
8	GSDP	Fuel Man.	N	PS2	Pressure Switch to Manifold	MS 33649-04
22	GSDP	Dil. Man.	N	PS3	Pressure Switch to Manifold	MS 33649-04
36	GSDP	HPO2 Man	N	PS1	Pressure Switch to Manifold	MS 33649-04
50	GSDP	N2HP	N	PS4	Pressure Switch to Manifold	MS 33649-04

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
		Man.				
154	EVP	ACA	Y	QD7	QD7 to MV9	MS 33649-04
243	GC	Ar manifold	N	QD10	QD to manifold	MS 33649-04
266	GC	He manifold	N	QD9	QD to manifold	MS 33649-04
289	GC	-----	N	QD8	QD to manifold	MS 33649-04
105	IRR	-----	Y	QD11	QD inside IRR from Fuel Manifold	MS 33649-04
152	EVP	ACA	Y	----	Exit Port to Block	MS 33649-04
159	EVP	ACA	Y	QD6	QD6 to MV10	MS 33649-04
177	EVP	Vent Man	Y	PS7	Pressure Switch to Manifold	MS 33649-04
115	End Cap	-----	Y	PS8	Pressure Switch to End Cap	MS 33649-04
116	End Cap	-----	Y	PS9	Pressure Switch to End Cap	MS 33649-04
2	GSDP	Fuel Man.	N	MV14	Bleed Valve to Manifold	MS 33649-04
16	GSDP	Dil. Man.	N	MV13	Bleed Valve to Manifold	MS 33649-04
30	GSDP	HPO2 Man	N	MV12	Bleed Valve to Manifold	MS 33649-04
44	GSDP	N2HP Man.	N	MV11	Bleed Valve to Manifold	MS 33649-04
244	GC	Ar manifold	N	MV17	Bleed valve to manifold	MS 33649-04
267	GC	He manifold	N	MV16	Bleed valve to manifold	MS 33649-04
290	GC	-----	N	MV15	Bleed valve to manifold	MS 33649-04
99	IRR	-----	Y	PT16	Pressure Transducer to IRR	MS 33649-04
100	IRR	-----	Y	PT17	Pressure Transducer to IRR	MS 33649-04
176	EVP	Vent Man	Y	PT31	Pressure Transducer to Manifold	MS 33649-04
112	End Cap	-----	Y	PT29	Pressure Transducer to End Cap	MS 33649-04
111	End Cap	-----	Y	PT28	Pressure Transducer to End Cap	MS 33649-04
14	GSDP	Fuel Man.	N	-----	Exit Port to Manifold	MS 33649-06
58	GSDP	N2HP Man.	N	-----	Exit Port to Manifold	MS 33649-06
28	GSDP	Dil. Man.	N	CV6	Check Valve/Exit Port to Manifold	MS 33649-06
42	GSDP	HPO2 Man	N	CV7	Check Valve/Exit Port to Manifold	MS 33649-06
56	GSDP	N2HP Man.	N	CV8	Check Valve/Exit Port to Manifold	MS 33649-06
1	GSDP	Fuel Man.	N	QD2	QD to QD Plate	MS 33649-06
15	GSDP	Dil. Man.	N	QD3	QD to QD Plate	MS 33649-06

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
29	GSDP	HPO2 Man	N	QD1	QD to QD Plate	MS 33649-06
43	GSDP	N2HP Man.	N	QD4	QD to QD Plate	MS 33649-06
106	IRR	-----	Y	QD12	QD inside IRR from H. P. Nitrogen	MS 33649-06
83	GSDP	SMM	N	-----	Static Mixer Housing to SMM	MS 33649-08
107	IRR	-----	Y	QD13	QD inside IRR from SMM	MS 33649-08
84	GSDP	SMM	N	-----	Static Mixer Housing to Fitting	MS 33649-08
108	IRR	-----	N	-----	Inlet to SV18 from SMM	MS 33649-08
129	EVP	Exhst Man	Y	----	Inlet Port to Manifold	MS 33649-08
144	EVP	Exhst Man	Y	----	Exit Port to Manifold	MS 33649-08
172	EVP	MVB	Y	----	Inlet Port to Manifold	MS 33649-08
183	EVP	Vent Man	Y	----	Inlet Port to Manifold	MS 33649-08
186	EVP	Vent Man	Y	----	Exit Port to Manifold	MS 33649-08
224	IRR	-----	Y	----	Outlet to EVP from SV21	MS 33649-08
231	EVP	-----	Y	----	Pass-thu port on front of optics plate	MS 33649-08
234	EVP	-----	Y	----	Pass-thu port on back of optics plate	MS 33649-08
237	EVP	-----	Y	----	Pass-thu port on front of optics plate	MS 33649-08
240	EVP	-----	Y	----	Pass-thu port on back of optics plate	MS 33649-08
322	EVP	MVB	Y	-----	Inlet Port to Manifold	MS 33649-08
173	EVP	MVB	Y	QD5	QD5 to Manual Valve Block	MS 33649-08
178	EVP	Vent Man	Y	DPS1	Dew Point Sensor to Manifold	MS 33649-08
199	EVP	Vent Man	Y	----	Inlet Port to Manifold	MS 33649-08
202	EVP	Vent Man	Y	----	Exit Port to Manifold	MS 33649-08
189	EVP	Vent Man	Y	----	SV23 inlet (at the solenoid)	o-ring
148	EVP	Exhst Man	Y	PI5	Pressure Indicator to Manifold	Single O-ring
4	GSDP	Fuel Man.	N	PI2	Pressure Indicator to Manifold	Single O-ring
18	GSDP	Dil. Man.	N	PI3	Pressure Indicator to Manifold	Single O-ring
32	GSDP	HPO2 Man	N	PI1	Pressure Indicator to Manifold	Single O-ring
46	GSDP	N2HP	N	PI4	Pressure Indicator to Manifold	Single O-ring

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
		Man.				
96	IRR	-----	Y	-----	Stand-Off for MV5 to IRR	Single O-ring
246	GC	Ar manifold	N	PI7	Pressure indicator to manifold	Single O-ring
269	GC	He manifold	N	PI6	Pressure indicator to manifold	Single O-ring
292	GC	-----	N	PI5	Pressure indicator to manifold	Single O-ring
345	GC	GCI	Y	PS6	Pressure Switch to Manifold	Single O-ring
257	GC	Ar manifold	N	RV3	Relief valve to manifold	Single O-ring
258	GC	Ar manifold	N	RV4	Relief valve to manifold	Single O-ring
280	GC	He manifold	N	RV1	Relief valve to manifold	Single O-ring
281	GC	He manifold	N	RV2	Relief valve to manifold	Single O-ring
147	EVP	Exhst Man	Y	PT30	Pressure Transducer to Manifold	Viton Cage
164	EVP	MVB	Y	PT13	Pressure Transducer to Manifold	Viton Cage
92	IRR	-----	N	PT15	Pressure Transducer to Manifold	Viton Cage
94	IRR	-----	N	PT25	Pressure Transducer to IRR	Viton Cage
256	GC	Ar manifold	N	PT19	Pressure transducer to manifold	Viton cage
279	GC	He manifold	N	PT20	Pressure transducer to manifold	Viton cage
302	GC	-----	N	PT22	Pressure transducer to manifold	Viton cage
333	GC	GCI	Y	PT21	Pressure transducer to manifold	Viton cage
344	GC	GCI	Y	PT23	Pressure transducer to manifold	Viton cage
365	GC	GCI	Y	PT14	Pressure transducer to manifold	Viton cage
3	GSDP	Fuel Man.	N	PT4	Pressure Transducer to Manifold	Viton Cage
9	GSDP	Fuel Man.	N	PT5	Pressure Transducer to Manifold	Viton Cage
17	GSDP	Dil. Man.	N	PT7	Pressure Transducer to Manifold	Viton Cage
23	GSDP	Dil. Man.	N	PT18	Pressure Transducer to Manifold	Viton Cage
31	GSDP	HPO2 Man	N	PT1	Pressure Transducer to Manifold	Viton Cage
37	GSDP	HPO2 Man	N	PT2	Pressure Transducer to Manifold	Viton Cage
45	GSDP	N2HP Man.	N	PT10	Pressure Transducer to Manifold	Viton Cage
51	GSDP	N2HP Man.	N	PT11	Pressure Transducer to Manifold	Viton Cage
247	GC	Ar manifold	N	PT26	Pressure transducer to manifold	Viton cage

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
270	GC	He manifold	N	PT27	Pressure transducer to manifold	Viton cage
293	GC	-----	N	PT24	Pressure transducer to manifold	Viton cage
11	GSDP	Fuel Man.	N	PT6	Pressure Transducer to Manifold	Viton Cage
25	GSDP	Dil. Man.	N	PT9	Pressure Transducer to Manifold	Viton Cage
39	GSDP	HPO2 Man	N	PT3	Pressure Transducer to Manifold	Viton Cage
53	GSDP	N2HP Man.	N	PT12	Pressure Transducer to Manifold	Viton Cage
156	EVP	ACA	Y	AC1	Fitting to Endcap	Weld
158	EVP	ACA	Y	AC1	Fitting to Endcap	Weld
180	EVP	DPS-MFC	Y	----	Fitting to Tube	Weld
182	EVP	MFC-SV	Y	----	Fitting to Tube	Weld
262	GC	Ar - GCI	N	-----	Fitting to tube	Weld
263	GC	Ar - GCI	N	-----	Tube to fitting	Weld
285	GC	He - GCI	N	-----	Fitting to tube	Weld
286	GC	He - GCI	N	-----	Tube to fitting	Weld
306	GC	-----	N	-----	Fitting to tube	Weld
307	GC	-----	N	-----	Tube to fitting	Weld
312	GC	GCI	Y	-----	Tube to fitting	Weld
324	IRR	-----	Y	-----	Tube to fitting	Weld
327	GC	GCI	Y	-----	Tube to fitting	Weld
349	GC	GCI	Y	-----	Tube to fitting	Weld
368	GC	GCI	Y	-----	Tube to fitting	Weld
377	GC	GCI	N	-----	Tube to fitting	Weld
379	GC	GCI	N	-----	Tube to fitting	Weld
482	GC	GCI	N	-----	Fitting to Tube	Weld
485	GC	GCI	Y	-----	Fitting to Tube	Weld
60	GSDP	Fuel - IRR	N	-----	Fitting to Tube	Weld
61	GSDP	Fuel - IRR	N	-----	Tube to Fitting	Weld
64	GSDP	Dil - SMM	N	-----	Fitting to Tube	Weld
65	GSDP	Dil - SMM	N	-----	Tube to Fitting	Weld
69	GSDP	O2 - SMM	N	-----	Fitting to Tube	Weld
70	GSDP	O2 - SMM	N	-----	Tube to Fitting	Weld
74	GSDP	N2 - SMM	N	-----	Fitting to Tube	Weld

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
75	GSDP	N2 - SMM	N	-----	Tube to Fitting	Weld
79	GSDP	N2 - IRR	N	-----	Fitting to Tube	Weld
80	GSDP	N2 - IRR	N	-----	Tube to Fitting	Weld
134	EVP	IRR-Exh	Y	----	Fitting to Tube	Weld
137	EVP	Exh-AC	Y	----	Fitting to Tube	Weld
140	EVP	Exh-GC	Y	----	Fitting to Tube	Weld
143	EVP	Exh-SM	Y	----	Fitting to Tube	Weld
151	EVP	ACA-Exh	Y	----	Fitting to Tube	Weld
162	EVP	ACA-MVB	Y	Flexhose	Fitting to Flexhose	Weld
167	EVP	MVB-Pthu	Y	----	Fitting to Tube	Weld
191	EVP	Pthu-vent	Y	----	Fitting to Tube	Weld
194	EVP	Vent-Pump	Y	----	Fitting to Tube	Weld
197	EVP	Vent - DPS	Y	----	Fitting to Tube	Weld
207	EVP	Vent-Pump	Y	----	Fitting to Tube	Weld
210	EVP	Vent-Pump	Y	----	Fitting to Tube	Weld
213	EVP	Vent-Pump	Y	----	Fitting to Tube	Weld
216	EVP	Vent-Pump	Y	----	Fitting to Tube	Weld
220	EVP	Pumps - F7	Y	----	Fitting to Tube	Weld
222	EVP	F7-Endcap	Y	----	Fitting to Tube	Weld
227	EVP	-----	Y	----	Fitting to Tube	Weld
230	EVP	-----	Y	----	Fitting to Tube	Weld
317	GSDP	SMM	N	-----	Tube to fitting	Weld
319	End Cap	-----	Y	-----	Tube to fitting	Weld
217	EVP	Vent-Pump	Y	Tee	tube to fitting (3 connections)	Weld
218	EVP	Pump-End	Y	Tee	tube to fitting (3 connections)	Weld
315	GC	GCI	N	-----	Tube to fitting	Weld
198	EVP	Tube Route	Y	Tee	tube to fitting (3 connections)	Weld
250	GC	Ar manifold	N	-----	Elbow fitting to ultraseal fitting	Weld

#	Package	Sub-Pack	Toxic	Schematic	Fitting Interface Description	Interface
251	GC	Ar manifold	N	-----	Elbow fitting to ultraseal fitting	Weld
273	GC	He manifold	N	-----	Elbow fitting to ultraseal fitting	Weld
274	GC	He manifold	N	-----	Elbow fitting to ultraseal fitting	Weld
296	GC	-----	N	-----	Elbow fitting to ultraseal fitting	Weld
297	GC	-----	N	-----	Elbow fitting to ultraseal fitting	Weld
131	EVP	IRR-Exh	Y	----	Fitting to Tube	Weld
146	EVP	Exh-Pthu	Y	----	Fitting to Tube	Weld
169	EVP	MVB	Y	----	Fitting to Tube	Weld
171	EVP	MVB	Y	----	Fitting to Tube	Weld
185	EVP	Pthu-vent	Y	----	Fitting to Tube	Weld
188	EVP	DPS-MFC	Y	----	Fitting to Tube	Weld
233	EVP	-----	Y	----	Fitting to Tube	Weld
236	EVP	-----	Y	----	Fitting to Tube	Weld
239	EVP	-----	Y	----	Fitting to Tube	Weld
242	EVP	-----	Y	----	Fitting to Tube	Weld
326	IRR	-----	Y	-----	Tube to fitting	Weld
86	GSDP	SMM	N	-----	Fitting to Tube	Weld
87	GSDP	SMM	N	-----	Tube to Fitting	Weld
124	EVP	Tube Route	Y	Tee	tube to fitting (3 connections)	Weld
122	EVP	Tube Route	Y	-----	reducer to 1/2" tube side	Weld
248	GC	Ar manifold	N	PR7	Regulator inlet to elbow	Weld
249	GC	Ar manifold	N	PR7	Regulator outlet to elbow	Weld
271	GC	He manifold	N	PR8	Regulator inlet to elbow	Weld
272	GC	He manifold	N	PR8	Regulator outlet to elbow	Weld
294	GC	-----	N	PR6	Regulator inlet to elbow	Weld
295	GC	-----	N	PR6	Regulator outlet to elbow	Weld
201	EVP	Pthu - vent	Y	----	Fitting to Tube	Weld
204	EVP	Vent-Pthu	Y	----	Fitting to Tube	Weld
119	EVP	Tube Route	Y	Cross	tube to fitting (4 connections)	Weld

APPENDIX F CIR INTERNAL ENVIRONMENTAL CONTROL SYSTEM INTERFACES

F.1 Scope.

This section gives the CIR internal environmental control system interfaces.

F.2 CIR internal environmental control system interfaces.

The CIR internal environmental control system interfaces are given in Table XXXII.

Table XXXII. CIR internal environmental control system interfaces

Interface	Connection	Fluid
WTCS to EPCU	Self-Sealing Fluid QD’s, Power	Cool Water
WTCS to ATCU	Self-Sealing Fluid QD’s	Cool Water
WTCS to ARIS Coldplate	Self-Sealing Fluid QD’s	Cool Water
WTCS to Science	Self-Sealing QD’s	Cool Water
GN2 to Nitrogen Manifold	Self-Sealing QD’s	Nitrogen
Manual Vent Valve Manifold to VES	Self-Sealing QD’s	Waste Gas

APPENDIX G REQUIREMENT/VERIFICATION CROSS-REFERENCE.

G.1 Scope.

This section contains the requirement/verification cross-reference matrix.

G.2 Requirement/verification cross-reference.

Verification Method:	
NA – Not Applicable	NVR – No Verification Required
I – Inspection	A – Analysis
D – Demonstration	T – Test

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Performance characteristics	3.2.1	4.1	I
Utilization	3.2.1.1	4.1.1	A
Minimum utilization	3.2.1.1.1	4.1.1.1	A
Additional utilization	3.2.1.1.2	4.1.1.2	A
Utilization capacity	3.2.1.1.3	4.1.1.3	A
Basis experiment capacity	3.2.1.1.3.1	4.1.1.3.1	A
Initial scheduled experiment capacity	3.2.1.1.3.2	4.1.1.3.2	I
Combustion chamber science volume	3.2.1.2	4.1.2	I & A
Combustion chamber science width	3.2.1.3	4.1.3	I
Combustion chamber internal cleanliness	3.2.1.4	4.1.4	NVR
Initial combustion chamber internal cleanliness	3.2.1.4.1	4.1.4.1	I
Combustion chamber cleanliness on orbit	3.2.1.4.2	4.1.4.2	T
Fuel/oxidizer storage	3.2.1.5	4.1.5	A
Gas distribution	3.2.1.6	4.1.6	T
Gas mixing	3.2.1.7	4.1.7	T
Ignition interface	3.2.1.8	4.1.8	T
Science acceleration and vibration	3.2.1.9	4.1.9	A
Initial combustion chamber pressure	3.2.1.10	4.1.10	T
Containment pressure	3.2.1.11	4.1.11	A & T
Initial gas temperatures	3.2.1.12	4.1.12	A
Condensed phase fuel temperatures	3.2.1.13	4.1.13	A
Science oxygen compatibility	3.2.1.14	4.1.14	A & I
Gas blending	3.2.1.15	4.1.15	T
Premixed gases	3.2.1.16	4.1.16	A

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Gaseous fuel flow	3.2.1.17	4.1.17	T
Gaseous oxidizer/diluent flow	3.2.1.18	4.1.18	A & T
Test point durations	3.2.1.19	4.1.19	A & T
Number of test points	3.2.1.20	4.1.20	A & T
Visible imaging	3.2.1.21	4.1.21	T
Visible imaging framing rate	3.2.1.21.1	4.1.21.1	T
Visible imaging resolution	3.2.1.21.2	4.1.21.2	T
Visible imaging field of view	3.2.1.21.3	4.1.21.3	T
Visible imaging depth of field	3.2.1.21.4	4.1.21.4	T
Visible imaging lateral/axial field of view	3.2.1.21.5	4.1.21.5	T
Visible imaging illumination	3.2.1.21.6	4.1.21.6	T
Infrared (IR) imaging	3.2.1.22	4.1.22	T
IR imaging framing rate	3.2.1.22.1	4.1.22.1	T
IR imaging field of view	3.2.1.22.2	4.1.22.2	T
IR imaging depth of field	3.2.1.22.3	4.1.22.3	T
IR imaging lateral/axial field of view	3.2.1.22.4	4.1.22.4	T
Ultraviolet (UV) imaging	3.2.1.23	4.1.23	T
UV imaging framing rate	3.2.1.23.1	4.1.23.1	T
UV imaging resolution	3.2.1.23.2	4.1.23.2	T
UV imaging field of view	3.2.1.23.3	4.1.23.3	T
UV imaging depth of field	3.2.1.23.4	4.1.23.4	T
UV imaging lateral/axial field of view	3.2.1.23.5	4.1.23.5	T
Gas phase temperature point measurements	3.2.1.24	4.1.24	T
Gas phase temperature point measurement range	3.2.1.24.1	4.1.24.1	T
Condensed phase temperature point measurements	3.2.1.25	4.1.25	T
Condensed phase temperature point measurement range	3.2.1.25.1	4.1.25.1	T
Gas phase temperature field measurements	3.2.1.26	4.1.26	T
Gas phase temperature field measurement sampling rate	3.2.1.26.1	4.1.26.1	T
Gas phase temperature field measurement resolution	3.2.1.26.2	4.1.26.2	T
Gas phase temperature field measurement lateral/axial field of view	3.2.1.26.3	4.1.26.3	T
Condensed phase temperature field measurements	3.2.1.27	4.1.27	T
Condensed phase temperature field	3.2.1.27.1	4.1.27.1	T

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
measurement sampling rate			
Condensed phase temperature field measurement resolution	3.2.1.27.2	4.1.27.2	T
Condensed phase temperature field measurement lateral/axial field of view	3.2.1.27.3	4.1.27.3	T
Pressure measurements	3.2.1.28	4.1.28	T
Pressure measurement sampling rate	3.2.1.28.1	4.1.28.1	T
Pressure measurement range	3.2.1.28.2	4.1.28.2	T
Chemical composition measurements	3.2.1.29	4.1.29	A & T
Chemical composition measurement constituents	3.2.1.29.1	4.1.29.1	T
Gas composition measurement range	3.2.1.29.2	4.1.29.2	T
Soot measurements	3.2.1.30	4.1.30	T
Soot volume fraction measurement lateral/axial field of view	3.2.1.30.1	4.1.30.1	T
Soot volume fraction measurement resolution.	3.2.1.30.2	4.2.1.30.2	T
Radiometry measurements	3.2.1.31	4.1.31	T
Radiometry measurement sampling rates	3.2.1.31.1	4.1.31.1	T
Velocity point measurements	3.2.1.32	4.1.32	T
Velocity point measurement sampling rate	3.2.1.32.1	4.1.32.1	T
Velocity point measurement velocity range	3.2.1.32.2	4.1.32.2	T
Full field velocity imaging	3.2.1.33	4.1.33	T
Full field velocity imaging framing rate	3.2.1.33.1	4.1.33.1	T
Acceleration measurements	3.2.1.34	4.1.34	A
Acceleration measurement sampling rate	3.2.1.34.1	4.1.34.1	T
Data time reference	3.2.1.35	4.1.35	T
Data time reference for experiment events	3.2.1.35.1	4.1.35.1	T
Data time reference for external events	3.2.1.35.2	4.1.35.2	T
Simultaneous measurements	3.2.1.36	4.1.36	A
On-orbit instrument calibration	3.2.1.37	4.1.37	T
Replacement of on-orbit instruments	3.2.1.37.1	4.1.37.1	D
Rack environment monitoring	3.2.1.38	4.1.38	A & T
On-orbit data storage	3.2.1.39	4.1.39	I
On-orbit data collection and transfer	3.2.1.40	4.1.40	NVR
Processing and providing data	3.2.1.40.1a	4.1.40.1a	I & T
Processing and providing data	3.2.1.40.1b	4.1.40.1b	I & T

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Processing and providing data	3.2.1.40.1c	4.1.40.1c	T
Processing and providing data	3.2.1.40.1d	4.1.40.1d	I & T
Processing and providing data	3.2.1.40.1e	4.1.40.1e	T
Processing and providing data	3.2.1.40.1f	4.1.40.1f	T
Processing and providing data	3.2.1.40.1g	4.1.40.1g	T
On-orbit data transfer within FCF	3.2.1.40.2	4.1.40.2	T
Use of fiber optics	3.2.1.40.3	4.1.40.3	I
On-orbit data transfer to portable media	3.2.1.40.4	4.1.40.4	I & T
CIR health status monitoring	3.2.1.41	4.1.41	T
CIR/FCF health status monitoring	3.2.1.41.1	4.1.41.1	T
CIR/FCF health status monitoring	3.2.1.41.1.1	4.1.41.1.1	T
CIR/ISS health status monitoring	3.2.1.41.2	4.1.41.2	T
CIR Commanding	3.2.1.42	4.1.42	NVR
SCC Commanding	3.2.1.42.1	4.1.42.1	T
Ground Commanding	3.2.1.42.2	4.1.42.2	T
Commanding through SAR	3.2.1.42.3	4.1.42.3	T
Manual inputs.	3.2.1.42.4	4.1.42.4	I
Upgrading of CIR maintenance items	3.2.1.43	4.1.43	A
Use of FIR capabilities	3.2.1.44	3.1.44	A
Control the CIR	3.2.1.45a	4.1.45a	T
Control the CIR	3.2.1.45b	4.1.45b	T
Physical characteristics	3.2.2	4.2	NVR
CIR dimensional characteristics	3.2.2.1	4.2.1	NVR
CIR launch envelope	3.2.2.1.1	4.2.1.1	A & T
CIR on-orbit envelope	3.2.2.1.2	4.2.1.2	A & T
CIR stowage volume	3.2.2.1.3a	4.2.1.3a	A & T
CIR stowage volume	3.2.2.1.3b	3.2.2.1.3b	A
CIR maintenance item stowage	3.2.2.1.4	4.2.1.4	A & T
CIR weight characteristics	3.2.2.2 a.	4.2.2 a.	A & D
CIR weight characteristics	3.2.2.2 b.	4.2.2 b.	A & D
CIR weight characteristics	3.2.2.2 c.	4.2.2 c.	A & D
CIR power	3.2.2.3 a.	4.2.3 a.	A
CIR power	3.2.2.3 b.	4.2.3 b.	A
CIR environmental control system power allocation	3.2.2.3.1	4.2.3.1	A & T
CIR power to PI avionics	3.2.2.3.2	4.2.3.2	I & T
CIR power to PI hardware inside combustion chamber	3.2.2.3.3	4.2.3.3	I & T
CIR heat rejection	3.2.2.4	4.2.4	A
PI avionics cooling air	3.2.2.5	4.2.5	A
Thermal cooling water	3.2.2.6	4.2.6	A & T

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Thermal water cooling inside combustion chamber	3.2.2.6.1	4.2.6.1	A & T
Durability	3.2.2.7 a.	4.2.7 a.	A
Durability	3.2.2.7 b.	4.2.7 b.	A
Transportation and safety requirements	3.2.2.8	4.2.8	NA
Interfaces	3.2.2.9 a.	4.2.9 a.	D
Interfaces	3.2.2.9 b.	4.2.9 b.	D
Interfaces	3.2.2.9c	4.2.9c	I
Ground support equipment (GSE) interfaces	3.2.2.9.1 a.	4.2.9.1 a.	I
Ground support equipment (GSE) interfaces	3.2.2.9.1 b.	4.2.9.1 b.	D
Ground support equipment (GSE) interfaces	3.2.2.9.1 c.	4.2.9.1 c.	D
Ground support equipment (GSE) interfaces	3.2.2.9.1 d.	4.2.9.1 d.	T & A
MPLM interfaces	3.2.2.9.2 a.	4.2.9.2 a.	I
MPLM interfaces	3.2.2.9.2 b.	4.2.9.2 b.	A
MPLM interfaces	3.2.2.9.2 c.	4.2.9.2 c.	A
COF interfaces	3.2.2.9.3	4.2.9.3	I
Reliability	3.2.3	4.3	NA
Maintainability	3.2.4	4.4	A
CIR maintenance access	3.2.4.1	4.4.1	D
Maintenance item temporary restraint and stowage	3.2.4.2	4.4.2	I
Tool usage for maintenance	3.2.4.3	4.4.3	A
Lockwiring and staking	3.2.4.4	4.4.4	I
Redundant paths	3.2.4.5	4.4.5	A
CIR reconfiguration for out-of-tolerance conditions	3.2.4.6	4.4.6	T
Availability	3.2.5	4.5	A
Environmental conditions	3.2.6	4.6	NVR
Shipping and storage environment	3.2.6.1	4.6.1	NVR
Nonoperating atmospheric environment	3.2.6.1.1 a.	4.6.1.1 a.	T
Nonoperating atmospheric environment	3.2.6.1.1 b.	4.6.1.1 b.	A
Nonoperating atmospheric environment	3.2.6.1.1 c.	4.6.1.1 c.	A
MPLM/on-orbit environmental conditions	3.2.6.2	4.6.2	A
On-orbit condensation	3.2.6.3	4.6.3	A
Special environmental conditions	3.2.6.4	4.6.4	NVR
Load requirements	3.2.6.4.1 a.	4.6.4.1 a.	A

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Load requirements	3.2.6.4.1 b.	4.6.4.1 b.	A
Load requirements	3.2.6.4.1 c.	4.6.4.1 c.	I
Load requirements	3.2.6.4.1 d.	4.6.4.1 d.	A
Load requirements	3.2.6.4.1 e.	4.6.4.1 e.	A
Load requirements	3.2.6.4.1 f.	4.6.4.1 f.	A
Rack requirements	3.2.6.4.2 a.	4.6.4.2 a.	A
Rack requirements	3.2.6.4.2 b.	4.6.4.2 b.	A
Rack requirements	3.2.6.4.2 c.	4.6.4.2 c.	NVR
Rack requirements	3.2.6.4.2 d.	4.6.4.2 d.	I or A
Rack requirements	3.2.6.4.2 e.	4.6.4.2 e.	A
Rack requirements	3.2.6.4.2 f.	4.6.4.2 f.	A
Rack requirements	3.2.6.4.2 g.	4.6.4.2 g.	A
Rack requirements	3.2.6.4.2 h.	4.6.4.2 h.	I
Rack requirements	3.2.6.4.2 i.	4.6.4.2 i.	I
Rack requirements	3.2.6.4.2 j.	4.6.4.2 j.	A
Rack requirements	3.2.6.4.2 k.	4.6.4.2 k.	A, T
Rack requirements	3.2.6.4.2 l.	4.6.4.2 l.	A or T
Rack requirements	3.2.6.4.2 m.	4.6.4.2 m.	A or T
Rack requirements	3.2.6.4.2 n.	4.6.4.2 n.	A
Electrical requirements	3.2.6.4.3	4.6.4.3	NVR
Steady-state voltage characteristics	3.2.6.4.3.1	4.6.4.3.1	T
Ripple voltage characteristics	3.2.6.4.3.2 a.	4.6.4.3.2 a.	A
Ripple voltage characteristics	3.2.6.4.3.2 b.	4.6.4.3.2 b.	A
Transient voltages	3.2.6.4.3.3	4.6.4.3.3	T or A
Fault clearing and protection	3.2.6.4.3.4	4.6.4.3.4	A
Non-normal voltage range	3.2.6.4.3.5	4.6.4.3.5	A
Power bus isolation	3.2.6.4.3.6 a.	4.6.4.3.6 a.	A
Power bus isolation	3.2.6.4.3.6 b.	4.6.4.3.6 b.	A
Compatibility with soft start/stop remote power controller (RPC)	3.2.6.4.3.7	4.6.4.3.7	T
Surge current	3.2.6.4.3.8	4.6.4.3.8	T & A
Reverse energy/current	3.2.6.4.3.9	4.6.4.3.9	A
Current protection devices	3.2.6.4.3.10 a.	4.6.4.3.10 a.	T
Current protection devices	3.2.6.4.3.10 b.	4.6.4.3.10 b.	A
Current protection devices	3.2.6.4.3.10 c.	4.6.4.3.10 c.	A
CIR trip ratings	3.2.6.4.3.11	4.6.4.3.11	T & D
Interface B complex load impedances	3.2.6.4.3.12	4.6.4.3.12	T
Large signal stability	3.2.6.4.3.13	4.6.4.3.13	T & A
Maximum ripple voltage emissions	3.2.6.4.3.14	4.6.4.3.14	T & A
Wire derating	3.2.6.4.3.15 a.	4.6.4.3.15 a.	A
Wire derating	3.2.6.4.3.15 b.	4.6.4.3.15 b.	I or A

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Exclusive power feeds	3.2.6.4.3.16	4.6.4.3.16	A
Loss of power	3.2.6.4.3.17	4.6.4.3.17	T
Electromagnetic compatibility	3.2.6.4.3.18	4.6.4.3.18	T, A, &/or I
Electrical grounding	3.2.6.4.3.18.1	4.6.4.3.18.1	T & A
Electrical bonding	3.2.6.4.3.18.2	4.6.4.3.18.2	T, A, & I
Cable/wire design and control requirements	3.2.6.4.3.18.3	4.6.4.3.18.3	T, A, or I
Electromagnetic interference	3.2.6.4.3.18.4	4.6.4.3.18.4	T & A
Electrostatic discharge	3.2.6.4.3.18.5	4.6.4.3.18.5	T or A & I
Alternating current (ac) magnetic fields	3.2.6.4.3.18.6	4.6.4.3.18.6	T
Direct current (dc) magnetic fields	3.2.6.4.3.18.7	4.6.4.3.18.7	T or A
Corona	3.2.6.4.3.18.8	4.6.4.3.18.8	A or T
Lightning	3.2.6.4.3.18.9	4.6.4.3.18.9	A
EMI susceptibility for safety-critical circuits	3.2.6.4.3.18.10	4.6.4.3.18.10	T & A
Transportability	3.2.7	4.7	A
CIR launch and return	3.2.7.1	4.7.1	A
Design and construction	3.3	4.8	NVR
Materials, processes, and parts	3.3.1	4.8.1	NVR
CIR specific material requirements	3.3.1.1	4.8.1.1	NVR
Materials – general	3.3.1.1.1	4.8.1.1.1	I
Fluids	3.3.1.1.2 a.	4.8.1.1.2 a.	T
Fluids	3.3.1.1.2 b.	4.8.1.1.2 b.	T
Fluids	3.3.1.1.2 c.	4.8.1.1.2 c.	I or A
Connectors	3.3.1.1.3	4.8.1.1.3	I
External cleanliness	3.3.1.1.4 a.	4.8.1.1.4 a.	I
External cleanliness	3.3.1.1.4 b.	4.8.1.1.4 b.	I
Toxic products and formulations	3.3.1.2	4.8.1.2	I
Volatile organic compounds	3.3.1.3	4.8.1.3	I
Hazardous materials	3.3.1.4	4.8.1.4	I
Protective coatings	3.3.1.5	4.8.1.5	I
Electromagnetic radiation	3.3.2	4.8.2	NVR
Ionizing radiation	3.3.2.1	4.8.2.1	NA
Nonionizing radiation	3.3.2.2	4.8.2.2	NA
Operating environment	3.3.2.3	4.8.2.3	NA
Generated environment	3.3.2.4	4.8.2.4	NA
Nameplates and product marking	3.3.3	4.8.3	NVR
Nameplates	3.3.3.1	4.8.3.1	NVR
CIR identification and marking	3.3.3.2	4.8.3.2	I
CIR component identification and marking	3.3.3.2.1 a. – d.	4.8.3.2.1 a. – d.	I

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CIR lighting design	3.3.3.2.2 a.	4.8.3.2.2 a.	T or I
CIR lighting design	3.3.3.2.2 b.	4.8.3.2.2 b.	T
CIR lighting design	3.3.3.2.2 c.	4.8.3.2.2 c.	A or T
CIR lighting design	3.3.3.2.2 d.	4.8.3.2.2 d.	I
CIR lighting design	3.3.3.2.2 e.	4.8.3.2.2 e.	I
CIR lighting design	3.3.3.2.2 f.	4.8.3.2.2 f.	I
Touch temperature warning labels	3.3.3.2.3	4.8.3.2.3	A & I
Connector coding and labeling	3.3.3.2.4 a.	4.8.3.2.4 a.	I
Connector coding and labeling	3.3.3.2.4 b.	4.8.3.2.4 b.	I
Connector coding and labeling	3.3.3.2.4 c.	4.8.3.2.4 c.	I
Portable fire extinguisher (PFE) and fire detection indicator labeling	3.3.3.3 a.	4.8.3.3 a.	I
Portable fire extinguisher (PFE) and fire detection indicator labeling	3.3.3.3 b.	4.8.3.3 b.	I
Electrostatic discharge sensitive parts labeling	3.3.3.4	4.8.3.4	I
Workmanship	3.3.4	4.8.4	I
Interchangeability	3.3.5	4.8.5	D
On-orbit interchangeability	3.3.5.1	4.8.5.1	D
Safety	3.3.6	4.8.6	A, I, & T
Fire prevention	3.3.6.1	4.8.6.1	A & I
Smoke detector	3.3.6.1.1 a.	4.8.6.1.1 a.	I
Smoke detector	3.3.6.1.1 b.	4.8.6.1.1 b.	I & D
Maintenance switch, smoke detector, smoke indicator, and CIR fan interfaces	3.3.6.1.1.1	4.8.6.1.1.1	I & T
Smoke indicator analog interface characteristics	3.3.6.1.1.2	4.8.6.1.1.2	I
Discrete command built-in-test interface characteristics	3.3.6.1.1.3	4.8.6.1.1.3	I
Smoke detector electrical interfaces	3.3.6.1.1.4	4.8.6.1.1.4	I & T
Fan ventilation status electrical interfaces	3.3.6.1.1.5	4.8.6.1.1.5	I
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6	4.8.6.1.1.6	I
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6 a.	4.8.6.1.1.6 a.	NVR
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6 b.	4.8.6.1.1.6 b.	I
Rack maintenance switch (rack power	3.3.6.1.1.6 c.	4.8.6.1.1.6 c.	I

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switch)/fire detection support interface connector			
Fire detection indicator	3.3.6.1.2 a.	4.8.6.1.2 a.	T & I
Fire detection indicator	3.3.6.1.2 b.	4.8.6.1.2 b.	I
Forced air circulation indication	3.3.6.1.3	4.8.6.1.3	T
Fire parameter monitoring in the CIR	3.3.6.1.4 a.	4.8.6.1.4 a.	T
Fire parameter monitoring in the CIR	3.3.6.1.4 b.	4.8.6.1.4 b.	T
Fire suppression access port accessibility	3.3.6.1.5 a.	4.8.6.1.5 a.	I & A
Fire suppression access port accessibility	3.3.6.1.5 b.	4.8.6.1.5 b.	D
Fire suppressant distribution	3.3.6.1.6	4.8.6.1.6	A or T
CIR front surface temperature	3.3.6.2	4.8.6.2	A or T
Electrical hazards	3.3.6.3 a.	4.8.6.3 a.	NVR
Electrical hazards	3.3.6.3 b.	4.8.6.3 b.	A &/or T
Electrical hazards	3.3.6.3 c.	4.8.6.3 c.	A &/or T
Electrical hazards	3.3.6.3 d.	4.8.6.3 d.	A &/or T
Connector mating	3.3.6.4	4.8.6.4	A, I, & D
Mating/demating of powered connectors	3.3.6.5	4.8.6.5	A
Safety-critical circuit redundancy	3.3.6.6	4.8.6.6	A
Rack maintenance switch (rack power switch)	3.3.6.7	4.8.6.7	I & D
Power switches/controls	3.3.6.8 a.	4.8.6.8 a.	A
Power switches/controls	3.3.6.8 b.	4.8.6.8 b.	A
Power switches/controls	3.3.6.8 c.	4.8.6.8 c.	A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 a.	4.8.6.9 a.	A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 b.	4.8.6.9 b.	T
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 c.	4.8.6.9 c.	T or A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 d.	4.8.6.9 d.	A & T
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 e.	4.8.6.9 e.	T or A
Ground fault circuit interrupters	3.3.6.9 f.	4.8.6.9 f.	T

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(GFCI)/portable equipment dc sourcing voltage			
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 g.	4.8.6.9 g.	A & D
Portable equipment/power cords	3.3.6.10 a.	4.8.6.10 a.	A
Portable equipment/power cords	3.3.6.10 b.	4.8.6.10 b.	A
Overload protection	3.3.6.11	4.8.6.11	NVR
Device accessibility	3.3.6.11.1	4.8.6.11.1	I
Extractor-type fuse holder	3.3.6.11.2	4.8.6.11.2	D
Overload protection location	3.3.6.11.3	4.8.6.11.3	I
Overload protection identification	3.3.6.11.4	4.8.6.11.4	I
Automatic restart protection	3.3.6.11.5	4.8.6.11.5	D
Sharp edges and corners protection	3.3.6.12	4.8.6.12	I
Holes	3.3.6.13	4.8.6.13	A & I
Latches	3.3.6.14	4.8.6.14	I
Screw and bolts	3.3.6.15	4.8.6.15	A & I
Securing pins	3.3.6.16	4.8.6.16	A
Levers, cranks, hooks, and controls	3.3.6.17	4..6.17	A & I
Burrs	3.3.6.18	4.83.6.18	I
Locking wires	3.3.6.19 a.	4.8.6.19 a.	A
Locking wires	3.3.6.19 b.	4.8.6.19 b.	I
Audio devices (displays)	3.3.6.20 a.	4.8.6.20 a.	A
Audio devices (displays)	3.3.6.20 b.	4.8.6.20 b.	D
Audio devices (displays)	3.3.6.20 c.	4.8.6.20 c.	A & D
Egress	3.3.6.21	4.8.6.21	A
Failure tolerance	3.3.6.22	4.8.6.22	A
Failure propagation	3.3.6.23 a.	4.8.6.23 a.	A
Failure propagation	3.3.6.23 b.	4.8.6.23 b.	A
Separation of redundant paths	3.3.6.24	4.8.6.24	A
Incorrect equipment installation	3.3.6.25	4.8.6.25	A
Chemical releases	3.3.6.26	4.8.6.26	A
Single event effect (SEE) ionizing radiation	3.3.6.27	4.8.6.27	A
Potential hazardous conditions	3.3.6.28	4.8.6.28	T
Withstand external environment	3.3.6.29	4.8.6.29	I
Human performance/human engineering	3.3.7	4.8.7	NVR
Strength requirements	3.3.7.1 a. (1)	4.8.7.1 a. (1)	A or D
Strength requirements	3.3.7.1 a. (2)	4.8.7.1 a. (2)	A or D
Strength requirements	3.3.7.1 a. (3)	4.8.7.1 a. (3)	A or D

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Strength requirements	3.3.7.1 b.	4.8.7.1 b.	A or D
Adequate crew clearance	3.3.7.2	4.8.7.2	A or D
Accessibility	3.3.7.3 a.	4.8.7.3 a.	A or D
Accessibility	3.3.7.3 b.	4.8.7.3 b.	A or D
Full size range accommodation	3.3.7.4	4.8.7.4	A
Housekeeping closures and covers	3.3.7.5	4.8.7.5	I
Built-in housekeeping control	3.3.7.6 a.	4.8.7.6 a.	I
Built-in housekeeping control	3.3.7.6 b.	4.8.7.6 b.	A or D
One-handed operation	3.3.7.7	4.8.7.7	D
Acoustic requirements	3.3.7.8	4.8.7.8	NVR
Continuous noise limits	3.3.7.8.1	4.8.7.8.1	A & T
Intermittent noise limits	3.3.7.8.2	4.8.7.8.2	A & T
CIR hardware mounting	3.3.7.9	4.8.7.9	NVR
Equipment mounting	3.3.7.9.1	4.8.7.9.1	A or D
Drawers and hinged panel	3.3.7.9.2	4.8.7.9.2	A
Alignment	3.3.7.9.3	4.8.7.9.3	A
Slide-out stops	3.3.7.9.4	4.8.7.9.4	I, A, or D
Push-pull force	3.3.7.9.5	4.8.7.9.5	A
Access	3.3.7.9.6	4.8.7.9.6	A or D
Covers	3.3.7.9.7	4.8.7.9.7	A
Self-supporting covers	3.3.7.9.8	4.8.7.9.8	A
Unique tools	3.3.7.9.9	4.8.7.9.9	A
Connectors	3.3.7.10	4.8.7.10	NVR
One-handed operation	3.3.7.10.1	4.8.7.10.1	A or D
Accessibility	3.3.7.10.2 a. (1)	4.8.7.10.2 a. (1)	A or D
Accessibility	3.3.7.10.2 a. (2)	4.8.7.10.2 a. (2)	A or D
Accessibility	3.3.7.10.2 b.	4.8.7.10.2 b.	A
Ease of disconnect	3.3.7.10.3 a.	4.8.7.10.3 a.	A
Ease of disconnect	3.3.7.10.3 b.	4.8.7.10.3 b.	A
Indication of pressure/flow	3.3.7.10.4	4.8.7.10.4	A
Self locking	3.3.7.10.5	4.8.7.10.5	A
Connector arrangement	3.3.7.10.6 a.	4.8.7.10.6 a.	I
Connector arrangement	3.3.7.10.6 b.	4.8.7.10.6 b.	I
Arc containment	3.3.7.10.7	4.8.7.10.7	A
Connector protection	3.3.7.10.8	4.8.7.10.8	A
Connector shape	3.3.7.10.9	4.8.7.10.9	A
Fluid and gas line connectors	3.3.7.10.10	4.8.7.10.10	A
Alignment marks or pin guides	3.3.7.10.11	4.8.7.10.11	I
Orientation	3.3.7.10.12	4.8.7.10.12	A

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Hose/cable restraints	3.3.7.10.13 a.	4.8.7.10.13 a.	I
Hose/cable restraints	3.3.7.10.13 b.	4.8.7.10.13 b.	I
Hose/cable restraints	3.3.7.10.13 c.	4.8.7.10.13 c.	NVR
Hose/cable restraints	3.3.7.10.13 d.	4.8.7.10.13 d.	I
Fasteners	3.3.7.11	4.8.7.11	NVR
Non-threaded fasteners status indication	3.3.7.11.1	4.8.7.11.1	D or I
Mounting bolt/fastener spacing	3.3.7.11.2	4.8.7.11.2	I
Multiple fasteners	3.3.7.11.3	4.8.7.11.3	I
Captive fasteners	3.3.7.11.4	4.8.7.11.4	A
Quick release fasteners	3.3.7.11.5 a.	4.8.7.11.5 a.	I
Quick release fasteners	3.3.7.11.5 b.	4.8.7.11.5 b.	I
Threaded fasteners	3.3.7.11.6	4.8.7.11.6	I
Over center latches	3.3.7.11.7 a.	4.8.7.11.7 a.	I
Over center latches	3.3.7.11.7 b.	4.8.7.11.7 b.	I
Over center latches	3.3.7.11.7 c.	4.8.7.11.7 c.	I
Winghead fasteners	3.3.7.11.8	4.8.7.11.8	I
Fasteners head type	3.3.7.11.9 a.	4.8.7.11.9 a.	I
Fasteners head type	3.3.7.11.9 b.	4.8.7.11.9 b.	I
Fasteners head type	3.3.7.11.9 c.	4.8.7.11.9 c.	I
One-handed operation	3.3.7.11.10	4.8.7.11.10	A or D
Access holes	3.3.7.11.11	4.8.7.11.11	I
Controls and displays	3.3.7.12	4.8.7.12	NVR
Controls spacing design requirements	3.3.7.12.1	4.8.7.12.1	I
Accidental actuation	3.3.7.12.2	4.8.7.12.2	NVR
Protective methods	3.3.7.12.2.1	4.8.7.12.2.1	I
Noninterference	3.3.7.12.2.2	4.8.7.12.2.2	I
Dead-man controls	3.3.7.12.2.3	4.8.7.12.2.3	NVR
Barrier guards	3.3.7.12.2.4	4.8.7.12.2.4	I
Recessed switch protection	3.3.7.12.2.5	4.8.7.12.2.5	I
Position indication	3.3.7.12.2.6	4.8.7.12.2.6	I
Hidden controls	3.3.7.12.2.7	4.8.7.12.2.7	I
Hand controllers	3.3.7.12.2.8	4.8.7.12.2.8	I
Valve controls	3.3.7.13 a.	4.8.7.13 a.	I
Valve controls	3.3.7.13 b.	4.8.7.13 b.	I
Valve controls	3.3.7.13 c.	4.8.7.13 c.	I
Valve controls	3.3.7.13 d.	4.8.7.13 d.	I
Valve controls	3.3.7.13 e.	4.8.7.13 e.	I
Toggle switches	3.3.7.14	4.8.7.14	I
Restraints and mobility aids	3.3.7.15	4.8.7.15	D or A
Captive parts	3.3.7.16	4.8.7.16	I

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Handle and grasp area design requirements	3.3.7.17	4.8.7.17	NVR
Handles and restraints	3.3.7.17.1	4.8.7.17.1	D or I
Handle location/front access	3.3.7.17.2	4.8.7.17.2	I
Handle dimensions	3.3.7.17.3	4.8.7.17.3	A or D
Non-fixed handles design requirements	3.3.7.17.4 a.	4.8.7.17.4 a.	A & D
Non-fixed handles design requirements	3.3.7.17.4 b.	4.8.7.17.4 b.	D
Non-fixed handles design requirements	3.3.7.17.4 c.	4.8.7.17.4 c.	I & D
Design requirements	3.3.8	4.8.8	NVR
Units of measure	3.3.8.1	4.8.8.1	I
Margins of safety/factors of safety	3.3.8.2	4.8.8.2	I
Allowable mechanical properties	3.3.8.3	4.8.8.3	I
Fracture control	3.3.8.4	4.8.8.4	I
CIR computer resource requirements	3.4	4.9	NVR
CIR computer hardware design considerations	3.4.1 a.	4.9.1 a.	T
CIR computer hardware design considerations	3.4.1 b.	4.9.1 b.	T
CIR computer hardware design considerations	3.4.1 c	4.9.1 c	T
Command and data requirements	3.4.1.1	4.9.1.1	NVR
Word/byte notations	3.4.1.1.1	4.9.1.1.1	I
Data types	3.4.1.1.2	4.9.1.1.2	I
Data transmissions	3.4.1.1.3 a.	4.9.1.1.3 a.	I
Data transmissions	3.4.1.1.3 b.	4.9.1.1.3 b.	I
Data transmissions	3.4.1.1.3 c.	4.9.1.1.3 c.	I
Consultative committee for space data systems	3.4.1.1.4 a.-c.	4.9.1.1.4 a.-c.	A or T
CCSDS data packets	3.4.1.1.4.1	4.9.1.1.4.1	T
CCSDS primary header	3.4.1.1.4.1.1	4.9.1.1.4.1.1	T
CCSDS secondary header	3.4.1.1.4.1.2	4.9.1.1.4.1.2	T
CCSDS data field	3.4.1.1.4.1.3	4.9.1.1.4.1.3	T
CCSDS application process identification field	3.4.1.1.4.1.4	4.9.1.1.4.1.4	T
CCSDS time codes	3.4.1.1.4.2	4.9.1.1.4.2	NVR
CCSDS unsegmented time	3.4.1.1.4.2.1	4.9.1.1.4.2.1	T
CCSDS segmented time	3.4.1.1.4.2.2	4.9.1.1.4.2.2	T
MIL-STD-1553B low rate data link (LRDL)	3.4.1.1.5	4.9.1.1.5	T
Standard messages	3.4.1.1.5.1	4.9.1.1.5.1	I & T
Commanding	3.4.1.1.5.2	4.9.1.1.5.2	T

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Health and status data	3.4.1.1.5.3	4.9.1.1.5.3	T & I
Safety data	3.4.1.1.5.4	4.9.1.1.5.4	T
Caution and warning	3.4.1.1.5.5	4.9.1.1.5.5	NVR
Class 2 – warning	3.4.1.1.5.5.1	4.9.1.1.5.5.1	A & T
Class 3 – caution	3.4.1.1.5.5.2	4.9.1.1.5.5.2	A & T
Class 4 – advisory	3.4.1.1.5.5.3	4.9.1.1.5.5.3	A & T
Service requests	3.4.1.1.5.6	4.9.1.1.5.6	T
File transfer	3.4.1.1.5.7	4.9.1.1.5.7	T
Low rate telemetry	3.4.1.1.5.8	4.9.1.1.5.8	T
Defined mode codes	3.4.1.1.5.9	4.9.1.1.5.9	T
Implemented mode codes	3.4.1.1.5.10	4.9.1.1.5.10	T
Illegal commands	3.4.1.1.5.11	4.9.1.1.5.11	T
LRDL interface characteristics	3.4.1.1.5.12 a.	4.9.1.1.5.12 a.	I
LRDL interface characteristics	3.4.1.1.5.12 b.	4.9.1.1.5.12 b.	I
Remote terminal hardwired address coding	3.4.1.1.5.12.1	4.9.1.1.5.12.1	T
LRDL signal characteristics	3.4.1.1.5.12.2	4.9.1.1.5.12.2	T
LRDL cabling	3.4.1.1.5.12.3	4.9.1.1.5.12.3	I
Multi-bus isolation	3.4.1.1.5.12.4	4.9.1.1.5.12.4	T
Medium rate data link (MRDL)	3.4.1.1.6	4.9.1.1.6	NVR
MRDL protocol	3.4.1.1.6.1	4.9.1.1.6.1	I & T
CIR protocols on the MRDL	3.4.1.1.6.2	4.9.1.1.6.2	I & T
MRDL address	3.4.1.1.6.3	4.9.1.1.6.3	I & T
CIR MRDL connectivity	3.4.1.1.6.4 a.	4.9.1.1.6.4 a.	I
CIR MRDL connectivity	3.4.1.1.6.4 b.	4.9.1.1.6.4 b.	T
CIR MRDL connectivity	3.4.1.1.6.4 c.	4.9.1.1.6.4 c.	T
CIR MRDL connectivity	3.4.1.1.6.4 d.	4.9.1.1.6.4 d.	A
MRDL connector/pin assignments and wire requirements	3.4.1.1.6.5 a.	4.9.1.1.6.5 a.	I
MRDL connector/pin assignments and wire requirements	3.4.1.1.6.5 b.	4.9.1.1.6.5 b.	I
MRDL connector/pin assignments and wire requirements	3.4.1.1.6.5 c.	4.9.1.1.6.5 c.	I
MRDL signal characteristics	3.4.1.1.6.6	4.9.1.1.6.6	I & T
MRDL cable characteristics	3.4.1.1.6.7	4.9.1.1.6.7	I
Differential characteristic impedance	3.4.1.1.6.7.1	4.9.1.1.6.7.1	T
CIR to high-rate frame multiplexer (HRFM) protocols	3.4.1.1.7	4.9.1.1.7	T
High rate data link (HRDL) physical signaling data rates	3.4.1.1.7.1	4.9.1.1.7.1	T & A
High rate data link (HRDL) physical	3.4.1.1.7.1 a.	4.9.1.1.7.1 a.	T

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
signaling data rates			
High rate data link (HRDL) physical signaling data rates	3.4.1.1.7.1 b.	4.9.1.1.7.1 b.	T
Encoding	3.4.1.1.7.2	4.9.1.1.7.2	I & T
Symbols used in testing	3.4.1.1.7.3	4.9.1.1.7.3	T
CIR HRDL transmitted optical power	3.4.1.1.7.4	4.9.1.1.7.4	T
HRDL fiber optic cable	3.4.1.1.7.5	4..1.1.7.5	I
HRDL fiber optic bend radius	3.4.1.1.7.6	4.94.1.1.7.6	I
HRDL connectors and fiber	3.4.1.1.7.7 a.	4.9.1.1.7.7 a.	I
HRDL connectors and fiber	3.4.1.1.7.7 b.	4.9.1.1.7.7 b.	I
HRDL connectors and fiber	3.4.1.1.7.7 c.	4.9.1.1.7.7 c.	I
Station support computer (SSC)	3.4.1.1.8 a.	4.9.1.1.8 a.	I
Station support computer (SSC)	3.4.1.1.8 b.	4.9.1.1.8 b.	D
CIR national television systems committee (NTSC) video and audio interface requirements	3.4.1.1.9	4.9.1.1.9	NVR
CIR NTSC video characteristics	3.4.1.1.9.1	4.9.1.1.9.1	T
Pulse frequency modulation NTSC fiber optic video characteristics	3.4.1.1.9.2	4.9.1.1.9.2	T
CIR NTSC PFM video transmitted optical power	3.4.1.1.9.3	4.9.1.1.9.3	T
Fiber optic cable characteristics	3.4.1.1.9.4	4.9.1.1.9.4	I
PFM NSTC video fiber optic cable bend radius	3.4.1.1.9.5	4.9.1.1.9.5	I
Flexibility and expansion	3.4.2 a.	4.9.2 a.	T
Flexibility and expansion	3.4.2 b.	4.9.2 b.	A & T
Flexibility and expansion	3.4.2 c.	4.9.2 c.	I
Flexibility and expansion	3.4.2 d.	4.9.2 d.	D
Flexibility and expansion	3.4.2 e.	4.9.2 e.	T
Flexibility and expansion	3.4.2 f.	4.9.2 f.	T
Flexibility and expansion	3.4.2 g.	4.9.2 g.	A
Flexibility and expansion	3.4.2 h.	4.9.2 h.	A
Flexibility and expansion	3.4.2 i.	4.9.2 i.	A
Flexibility and expansion	3.4.2 j.	4.9.2 j.	A
Flexibility and expansion	3.4.2 k.	4.9.2 k.	A
Flexibility and expansion	3.4.2 l.	4.9.2 l.	A
Software portability	3.4.3 a.	4.9.3 a.	T
Software portability	3.4.3 b.	4.9.3 b.	T
Data date/time stamps	3.4.4a	4.9.4a	I & T
Data date/time stamps	3.4.4b	4.9.4b	I & T
Logistics	3.5	4.10	NVR

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
Maintenance	3.5.1	4.10.1	D
Supply	3.5.2	4.10.2	A
Facilities and facility equipment	3.5.3	4.10.3	NA
Personnel and training	3.6	4.11	NVR
Personnel	3.6.1 a.	4.11.1 a.	D
Personnel	3.6.1 b.	4.11.1 b.	T
Personnel	3.6.1 c.	4.11.1 c.	D
Training	3.6.2	4.11.2	D
Major component characteristics	3.7	4.12	I
Water Thermal Control System (WTCS)	3.7.1 a. (1)	4.12.1 a. (1)	T
Water Thermal Control System (WTCS)	3.7.1 a. (2)	4.12.1 a. (2)	A
Water Thermal Control System (WTCS)	3.7.1 b.	4.12.1 b.	T
Water Thermal Control System (WTCS)	3.7.1 c.	4.12.1 c.	A or T
Water Thermal Control System (WTCS)	3.7.1 d.	4.12.1 d.	T & A
Water Thermal Control System (WTCS)	3.7.1 e.	4.12.1 e.	NVR
Water Thermal Control System (WTCS)	3.7.1 f. (1)	4.12.1 f. (1)	T & A
Water Thermal Control System (WTCS)	3.7.1 f. (2)	4.12.1 f. (2)	A
Water Thermal Control System (WTCS)	3.7.1 f. (3)	4.12.1 f. (3)	T & A
Water Thermal Control System (WTCS)	3.7.1 g.	4.12.1 g.	T
Water Thermal Control System (WTCS)	3.7.1 h.	4.12.1 h.	A &/or T
Water Thermal Control System (WTCS)	3.7.1 i.	4.12.1 i.	T
Water Thermal Control System (WTCS)	3.7.1 j.	4.12.1 j.	T or A
Water Thermal Control System (WTCS)	3.7.1 k.	4.12.1 k.	T
Water Thermal Control System (WTCS)	3.7.1 l.	4.12.1 l.	T or A
Water Thermal Control System (WTCS)	3.7.1 m.	4.12.1 m.	A
Water Thermal Control System	3.7.1 n.	4.12.1 n.	I or D

Paragraph Name	FCF-SPC-0002 Section 3 Requirement Number	CIR-PLN-0056 Section 4 Requirement Number	Verification Method
(WTCS)			
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 a.	4.12.2 a.	T & A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 b.	4.12.2 b.	T & A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 c.	4.12.2 c.	A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 d.	4.12.2 d.	T
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 e.	4.12.2 e.	T
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 f.	4.12.2 f.	A or T
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 g.	4.12.2 g.	A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 h.	4.12.2 h.	A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 i.	4.12.2 i.	A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 j.	4.12.2 j.	NVR
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 k.	4.12.2 k.	A
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 l.	4.12.2 l.	NVR
Vacuum exhaust system/waste gas system (VES/WGS) requirements	3.7.2 m.	4.12.2 m.	I & A
ISS nitrogen usage requirements	3.7.3 a.	4.12.3 a.	T
ISS nitrogen usage requirements	3.7.3 b.	4.12.3 b.	T & A
ISS nitrogen usage requirements	3.7.3 c.	4.12.3 c.	T &/or A
ISS nitrogen usage requirements	3.7.3 d.	4.12.3 d.	T
Preparation for delivery	5.0	4.13	NVR
Preservation	5.1	4.13.1	NVR
Packing	5.2	4.13.2	I
Launch configured CIR	5.2.1	4.13.2.1	I
Cleanliness	5.2.1.1	4.13.2.1.1	I
Procedures	5.2.1.2	4.13.2.1.2	I
Flight spares and other equipment	5.2.2	4.13.2.2	I
Marking and labeling	5.3	4.13.3	NA
Marking for shipment	5.4	4.13.4	I

APPENDIX H EXCEPTIONS

H.1 Scope.

This appendix documents the approved exceptions to this document.

H.2 3.2.4.1 CIR maintenance access exception.

The CIR shall be designed to allow for the replacement of assemblies and components and the performance of other maintenance activities without rotating the CIR from its installed position within the US Lab.

H.2.1 Exceptions to CIR maintenance access.

a. The CIR design requires rack rotation for ARIS maintenance activities.
b. The CIR design requires rack rotation for EPCU maintenance activities.

H.2.2 Rationales for exceptions to CIR maintenance access.

a. In order to minimize the impact to useable volume within the CIR, ARIS components are located in places not easily accessible when the CIR is in its on orbit configuration to meet its design requirements. A severe cost and science impact would be incurred to redesign the CIR to meet this requirement for ARIS.
b. The EPCU design would require modifications to its mounting equipment and umbilical design to meet the CIR maintenance requirement. The CIR would only need to be rotated from its installed position in the event of an off-nominal maintenance activity or replacement of the EPCU.

H.3 3.2.2.1.2 CIR on orbit envelope.

The CIR, with applicable PI hardware, shall have an on orbit envelope as specified in SSP 41017 Part1, paragraph 3.2.1.1.2 and shall follow the on orbit payload protrusion requirements as specified in SSP 57000, paragraph 3.1.1.7.

H.3.1 Exceptions to CIR on orbit envelope.

a. Exception to the on orbit temporary protrusions as specified in SSP 57000 to allow the CIR Optic Bench to protrude into the aisle for maintenance activities.
b. Exception to the on orbit temporary protrusions as specified in SSP 57000 to allow the CIR doors to protrude beyond the specified envelope for maintenance activities.

H.3.2 Rationales for exceptions to CIR on orbit envelope.

a. The CIR Optic Bench design minimizes crew resources and saves space by providing an alternative to rotating the rack for reconfiguration. The Optic Bench provides structural support, electrical connections, and mounting connections for all science support hardware. The Optic Bench will only be deployed while crew attended, meets human interface requirements for interfaces and operation as specified in SSP 57000, and allows for rapid reconfiguration of hardware for increased science thoughput. The design allows the Optic Bench to be quickly restowed and does not interfere with egress requirements. This exception has been approved by the ISS Payload Office under PIRN No. SSP 57217-NA-0001A.

b. The CIR door design does not interfere with the volumes for access and egress. The door sweep does not extend beyond the protrusion violation in the Optic Bench. The doors will only be open to perform maintenance and science activities on the CIR. This exception has been approved by the ISS payload Office under PIRN No. SSP 57217-NA-0003.

H.4 3.2.2.2 b. CIR weight characteristics.

The CIR, with applicable PI hardware, shall not exceed an on orbit mass of 804.2 kg (1773 lbs), excluding stowage hardware.

H.4.1 Exception to CIR weight characteristics.

Exception to the on orbit mass requirement of 804.2 kg (1773 lbs) to 1100 kg (2424.4 lbs) is required.

H.4.2 Rationale for exception to CIR weight characteristics.

Due to the extensive science requirements imposed on the CIR, a mass increase to 1100 kg (2424.4 lbs) is required to meet the science requirements. Analysis to reduce the mass has shown detrimental science reductions in the loss of cameras, observation ports, and support equipment. More crew and stowage resources would be required to perform the experiments. This exception has been approved by the ISS payload Office under PIRN No. SSP 57217-NA-0002.

APPENDIX I TBD'S

I.1 Scope.

This appendix lists all items in this document that need to be determined (TBD).

I.2 List of TBD's.

Table XX lists all the TBD's in this document.

TBD's

TBD Number	Description	Document Paragraph
04-01	Text for entire paragraph	4.1.1.3.2
04-02	Number of on-orbit MMCH/Y for scheduled and unscheduled maintenance activities	4.4
04-03	Number of Table that shows hand dimensions for sufficient grasp capability for the 5th percentile female and 95th percentile male	4.8.7.17.1